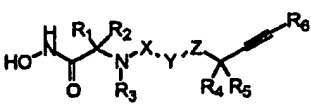


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁷ : C07C 311/00</p>	<p>A2</p>	<p>(11) International Publication Number: WO 00/44709 (43) International Publication Date: 3 August 2000 (03.08.00)</p>
<p>(21) International Application Number: PCT/US00/01981 (22) International Filing Date: 27 January 2000 (27.01.00) (30) Priority Data: 09/238,255 27 January 1999 (27.01.99) US (71) Applicant: AMERICAN CYANAMID COMPANY [US/US]; Five Giralda Farms, Madison, NJ 07940-0874 (US). (72) Inventors: LEVIN, Jeremy, Ian; 19 Long Meadow Drive, New City, NY 10956 (US). CHEN, James, Ming; 7 Sergeant David Stoddard Court, Bedminster, NJ 07921 (US). COLE, Derek, Cecil; 4 Rheinlander Lane, New City, NY 10956 (US). (74) Agents: BARRETT, Rebecca, R.; American Home Products Corporation, Patent Law Department -2B, One Campus Drive, Parsippany, NJ 07054 (US) et al.</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>Without international search report and to be republished upon receipt of that report.</i></p>
<p>(54) Title: ACETYLENIC α-AMINO ACID-BASED SULFONAMIDE HYDROXAMIC ACID TACE INHIBITORS</p> <div style="text-align: center;">  <p>(B)</p> </div> <p>(57) Abstract</p> <p>Compound of the formula (B) are useful in treating disease conditions mediated by TNF-α, such as rheumatoid arthritis, osteoarthritis, sepsis, AIDS, ulcerative colitis, multiple sclerosis, Crohn's disease and degenerative cartilage loss.</p>		

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ACETYLENIC α -AMINO ACID-BASED SULFONAMIDE HYDROXAMIC ACID TACE INHIBITORS

FIELD OF INVENTION

5 This invention relates to acetylenic aryl sulfonamide hydroxamic acids which act as inhibitors of TNF- α converting enzyme (TACE). The compounds of the present invention are useful in disease conditions mediated by TNF- α , such as rheumatoid arthritis, osteoarthritis, sepsis, AIDS, ulcerative colitis, multiple sclerosis, Crohn's disease and degenerative cartilage loss.

10

BACKGROUND OF THE INVENTION

TNF- α converting enzyme (TACE) catalyzes the formation of TNF- α from membrane bound TNF- α precursor protein. TNF- α is a pro-inflammatory cytokine that is believed to have a role in rheumatoid arthritis [Shire, M. G.; Muller, G. W. *Exp. Opin. Ther. Patents* **1998**, 8(5), 531; Grossman, J. M.; Brahn, E. J. *Women's Health* **1997**, 6(6), 627; Isomaki, P.; Punnonen, J. *Ann. Med.* **1997**, 29, 499; Camussi, G.; Lupia, E. *Drugs*, **1998**, 55(5), 613.] septic shock [Mathison, *et. al. J. Clin. Invest.* **1988**, 81, 1925; Miethke, *et. al. J. Exp. Med.* **1992**, 175, 91.], graft rejection [Piguet, P. F.; Grau, G. E.; *et. al. J. Exp. Med.* **1987**, 166, 1280.], cachexia [Beutler, B.; Cerami, A. *Ann. Rev. Biochem.* **1988**, 57, 505.], anorexia, inflammation [Ksontini, R.; MacKay, S. L. D.; Moldawer, L. L. *Arch. Surg.* **1998**, 133, 558.], congestive heart failure [Packer, M. *Circulation*, **1995**, 92(6), 1379; Ferrari, R.; Bachetti, T.; *et. al. Circulation*, **1995**, 92(6), 1479.], post-ischaemic reperfusion injury, inflammatory disease of the central nervous system, inflammatory bowel disease, insulin resistance [Hotamisligil, G. S.; Shargill, N. S.; Spiegelman, B. M.; *et. al. Science*, **1993**, 259, 87.] and HIV infection [Peterson, P. K.; Gekker, G.; *et. al. J. Clin. Invest.* **1992**, 89, 574; Pallares-Trujillo, J.; Lopez-Soriano, F. J. *Argiles, J. M. Med. Res. Reviews*, **1995**, 15(6), 533.]], in addition to its well-documented antitumor properties [Old, L. *Science*, **1985**, 230, 630.]. For example, research with anti-TNF- α antibodies and transgenic animals has demonstrated that blocking the formation of TNF- α inhibits the progression of arthritis [Rankin, E.C.; Choy, E.H.; Kassimos, D.; Kingsley, G.H.;

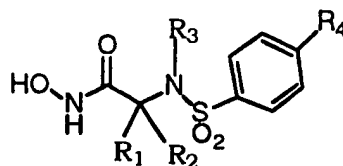
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25
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Sopwith, A.M.; Isenberg, D.A.; Panayi, G.S. *Br. J. Rheumatol.* **1995**, *34*, 334; *Pharmaprojects*, **1996**, Therapeutic Updates 17 (Oct.), au197-M2Z.]. This observation has recently been extended to humans as well as described in "TNF- α in Human Diseases", *Current Pharmaceutical Design*, **1996**, *2*, 662.

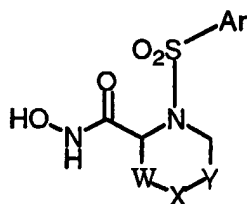
5 It is expected that small molecule inhibitors of TACE would have the potential for treating a variety of disease states. Although a variety of TACE inhibitors are known, many of these molecules are peptidic and peptide-like which suffer from bioavailability and pharmacokinetic problems. In addition, many of these molecules are non-selective, being potent inhibitors of matrix metalloproteinases and,
10 in particular, MMP-1. Inhibition of MMP-1 (collagenase 1) has been postulated to cause joint pain in clinical trials of MMP inhibitors [*Scrip*, **1998**, 2349, 20] Long acting, selective, orally bioavailable non-peptide inhibitors of TACE would thus be highly desirable for the treatment of the disease states discussed above.

U. S. patents 5,455,258, 5,506,242, 5,552,419, 5,770,624, 5,804,593, and
15 5,817,822 as well as European patent application EP606,046A1 and WIPO international publications WO9600214 and WO9722587 disclose non-peptide inhibitors of matrix metalloproteinases and/or TACE of which the aryl sulfonamide hydroxamic acid shown below is representative. Additional publications disclosing sulfonamide based MMP inhibitors which are variants of the sulfonamide-
20 hydroxamate shown below, or the analogous sulfonamide-carboxylates, are European patent applications EP-757037-A1 and EP-757984-A1 and WIPO international publications WO9535275, WO9535276, WO9627583, WO9719068, WO9727174, WO9745402, WO9807697, WO9831664, WO9833768, WO9839313, WO9839329, WO9842659 and WO9843963. The discovery of this type of MMP inhibitor is
25 further detailed by MacPherson, *et. al.* in *J. Med. Chem.*, **1997**, *40*, 2525 and Tamura, *et. al.* in *J. Med. Chem.* **1998**, *41*, 640.

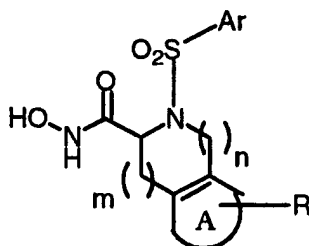


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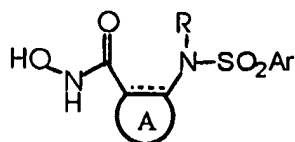
Publications disclosing β -sulfonamide-hydroxamate inhibitors of MMPs and/or TACE in which the carbon alpha to the hydroxamic acid has been joined in a ring to the sulfonamide nitrogen, as shown below, include U. S. patent 5,753,653, WIPO international publications WO9633172, WO9720824, WO9827069, WO9808815, WO9808822, WO9808823, WO9808825, WO9834918, WO9808827, Levin, *et. al. Bioorg. & Med. Chem. Letters* 1998, 8, 2657 and Pikul, *et. al. J. Med. Chem.* 1998, 41, 3568.



The patent applications DE19,542,189-A1, WO9718194, and EP803505 disclose additional examples of cyclic sulfonamides as MMP and/or TACE inhibitors. In this case the sulfonamide-containing ring is fused to a aromatic or heteroaromatic ring.

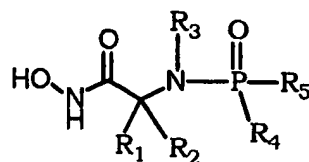


Examples of sulfonamide hydroxamic acid MMP/TACE inhibitors in which a 2 carbon chain separates the hydroxamic acid and the sulfonamide nitrogen, as shown below, are disclosed in WIPO international publications WO9816503, WO9816506, WO9816514 and WO9816520 and U. S. patent 5,776,961.



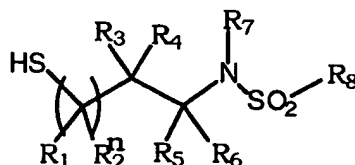
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Analogous to the sulfonamides are the phosphinic acid amide hydroxamic acid MMP/TACE inhibitors, exemplified by the structure below, which have been disclosed in WIPO international publication WO9808853.



5

Sulfonamide MMP/TACE inhibitors in which a thiol is the zinc chelating group, as shown below, have been disclosed in WIPO international application 9803166.



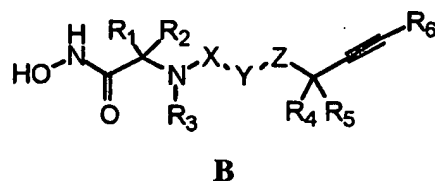
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It is an object of this invention to provide aryl sulfonamide hydroxamic acid MMP/TACE inhibitors in which the sulfonyl aryl group is para-substituted with a substituted butynyl moiety or a propargylic ether, amine or sulfide.

15

DETAILED DESCRIPTION OF THE INVENTION

The invention provides TACE and MMP inhibitors having the formula:



20 wherein:

X is SO₂ or -P(O)-R₁₀;

Y is aryl or heteroaryl, with the proviso that X and Z may not be bonded to adjacent atoms of Y;

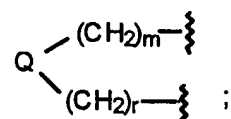
Z is O, NH, CH₂ or S;

25 R₁ is hydrogen, aryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

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R_2 is hydrogen, aryl, aralkyl, heteroaryl, heteroaralkyl, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

or R_1 and R_2 , together with the atom to which they are attached, may form a ring wherein R_1 and R_2 represent a divalent moiety of the formula:



wherein

Q = a carbon-carbon single or double bond, O, S, SO, SO₂, -N-R₁₁, or -CONR₁₄;

m = 1-3;

r = 1 or 2, with the proviso that when Q is a bond, r is equal to 2;

R_3 is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, aralkyl, or heteroaralkyl;

or R_1 and R_3 , together with the atoms to which they are attached, may form a 5 to 8 membered ring wherein R_1 and R_3 represent divalent moieties of the formulae:



wherein Q and m are as defined above;

A is aryl or heteroaryl;

s is 0-3;

u is 1-4;

R_4 and R_5 are each, independently, hydrogen or alkyl of 1-6 carbon atoms, -CN, or -CCH;

R_6 is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, or -C5-C8-cycloheteroalkyl;

R_8 and R_9 are each, independently, hydrogen, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl

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of 3-6 carbon atoms, aryl, aralkyl, heteroaryl, heteroaralkyl, or -C4-C8-cycloheteroalkyl;

R_{10} is alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl or heteroaryl;

5 R_{11} is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, $-S(O)_nR_8$, $-COOR_8$, $-CONR_8R_9$, $-SO_2NR_8R_9$ or $-COR_8$;

R_{12} and R_{13} are independently selected from H, $-OR_8$, $-NR_8R_9$, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, $-COOR_8$;
10 $-CONR_8R_9$; or R_{12} and R_{13} together form a -C3-C6-cycloalkyl of 3-6 carbon atoms or a -C5-C8-cycloheteroalkyl ring; or R_{12} and R_{13} together with the carbon to which they are attached, form a carbonyl group;

with the proviso that R_{10} and R_{12} or R_{11} and R_{12} may form a cycloheteroalkyl
15 ring when they are attached to adjacent atoms;

R_{14} is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms or cycloalkyl of 3-6 carbon atoms;

and n is 0-2;

or a pharmaceutically acceptable salt thereof.
20

Preferred compounds of this invention are those of structure **B** in which Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, or a pharmaceutically acceptable salt thereof.

More preferred compounds of this invention are those of structure **B** in which
25 Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO_2 , or a pharmaceutically acceptable salt thereof.

More preferred compounds of this invention are those of structure **B** in which Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO_2 , Z is oxygen.

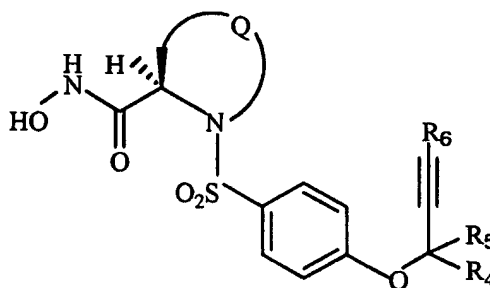
30 More preferred compounds of this invention are those of structure **B** in which Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO_2 , Z is oxygen and R_4 and R_5 are hydrogen.

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More preferred compounds of this invention are those of structure **B** in which Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO₂, Z is oxygen, R₄ and R₅ are hydrogen, and R₆ is -CH₂OH or methyl.

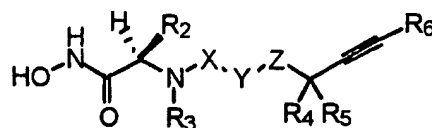
More preferred compounds of this invention are those of structure **B** in which
 5 R₁ and R₃, together with the atoms to which they are attached, form a piperazine, piperidine, tetrahydroisoquinoline, morpholine, thiomorpholine or diazepine ring.

More preferred compounds of this invention are those of structure **B** in which
 10 R₁ and R₃, together with the atoms to which they are attached, form a piperazine, piperidine, tetrahydroisoquinoline, morpholine, thiomorpholine or diazepine ring, and Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO₂, and Z is oxygen, or a pharmaceutically acceptable salt thereof.



More preferred compounds of this invention are those of structure **B** in which
 15 R₁ and R₃, together with the atoms to which they are attached, form a piperazine, piperidine, tetrahydroisoquinoline, morpholine, thiomorpholine or diazepine ring, Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO₂, Z is oxygen, and R₂ is hydrogen, such that structure **B** has the absolute stereochemistry shown above, or a pharmaceutically acceptable salt thereof.

20 More preferred compounds of this invention are those of structure **B** in which R₁ is hydrogen, such that these compounds have the D-configuration, as shown below:



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More preferred compounds of this invention are those of structure **B** in which R_1 is hydrogen, such that these compounds have the D-configuration, as shown above, and R_3 is hydrogen, or a pharmaceutically acceptable salt thereof.

Still more preferred compounds of this invention are those of structure **B** in which R_1 is hydrogen, such that these compounds have the D-configuration, as shown above, R_3 is hydrogen, Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO_2 , Z is oxygen, or a pharmaceutically acceptable salt thereof.

Most preferred compounds of the present invention are

- 10 2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-acetamide;
- 15 N-Hydroxy-2-[(4-methoxy-benzenesulfonyl)-methyl-amino]-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-acetamide hydrochloride;
- 20 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-acetamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-methyl-butylamide;
- 25 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-propionamide hydrochloride;
- 30 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-methyl-propionamide;
- 4-(4-But-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 35 4-(4-Hept-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 40 2-(4-But-2-ynyloxy-benzenesulfonyl)-1,2,3,4-tetrahydro-isoquinoline-3-carboxylic acid hydroxyamide;

- 4-Benzoyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-[1,4]diazepane-2-carboxylic acid hydroxyamide;
- 5 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid hydroxyamide hydrochloride;
- 4-[4-(4-Hydroxy-but-2-ynyloxy)-benzenesulfonyl]-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 10 4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid tert-butyl ester;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-methylpropionamide;
- 15 2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-guanidino-pentanoic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-(4-methylbenzenesulfonyl-guanidino)-pentanoic acid hydroxyamide;
- 20 3-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-succinamic acid cyclohexyl ester;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-3-cyclohexyl-N-hydroxy-propionamide;
- 25 2-(4-But-2-ynyloxy-benzenesulfonylamino)-2-cyclohexyl-N-hydroxy-acetamide
- 30 3-tert-Butylsulfanyl-2-(4-but-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(4-methoxy-benzylsulfanyl)-propionamide;
- 35 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N1-hydroxy-succinamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-3-cyclohexyl-N-hydroxy-propionamide;
- 40 2-(4-But-2-ynyloxy-benzenesulfonylamino)-2-cyclohexyl-N-hydroxy-acetamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-4-methyl-pentanoic acid hydroxyamide;
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- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-4-methylsulfanyl-butamide;
- 5 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-phenyl-propionamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-pyrrolidine-2-carboxylic acid hydroxyamide;
- 10 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(1H-indol-3-yl)-propionamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(4-hydroxy-phenyl)-propionamide;
- 15 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-methyl-butamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-4-methyl-pentanoic acid hydroxyamide;
- 20 2-(4-But-2-ynyloxy-benzenesulfonylamino)-6-(2-chloro-benzylamino)-hexanoic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-hexanoic acid hydroxyamide;
- 25 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-phenyl-acetamide;
- 3-Benzyloxy-2-(4-but-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 30 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-acetamide;
- (2R,3S)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-methyl-pentanamide;
- 35 (2R)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3,3-dimethyl-butanamide;
- (2S)-2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-propionamide;
- 40 2-[(4-But-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-N-hydroxy-3-methyl-butamide;
- 45 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(2-propynyl)amino]-N-hydroxy-3-methylbutanamide;

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- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-propyl-amino]-N-hydroxy-3-methyl-butylamide;
- 5 2-[(4-But-2-ynyloxy-benzenesulfonyl)-(3-phenyl-propyl)-amino]-N-hydroxy-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-cyclopropylmethyl-amino]-N-hydroxy-3-methyl-butylamide;
- 10 2-[(4-But-2-ynyloxy-benzenesulfonyl)-isobutyl-amino]-N-hydroxy-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-3-methyl-butylamide;
- 15 2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-2-cyclohexyl-N-hydroxy-acetamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-2-cyclohexyl-N-hydroxy-acetamide;
- 20 2-{(4-But-2-ynyloxy-benzenesulfonyl)-[4-(2-piperidin-1-yl-ethoxy)-benzyl]-amino}-2-cyclohexyl-N-hydroxy-acetamide;
- 25 2-{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(diethylamino)propyl]amino}-N-hydroxy-3-methylbutanamide;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-morpholinyl)propyl]amino}-N-hydroxy-3-methylbutanamide;
- 30 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-methyl-1-piperazinyl)propyl]amino}-N-hydroxy-3-methylbutanamide hydrochloride;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)butyl]amino}-N-hydroxy-3-methylbutanamide;
- 35 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)butyl]amino}-N-hydroxy-3-methylbutanamide;
- 40 2-[[[4-(2-Butynyloxy)phenyl]sulfonyl][2-(4-morpholinyl)ethyl]amino]-N-hydroxy-3-methylbutanamide;
- 45 2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](2-morpholin-4-ylethyl)amino]-N-hydroxyacetamide hydrochloride;

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- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 5 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(methylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 10 ((2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino})[(4-diethylamino)-cyclohexyl]-N-hydroxyethanamide;
- (2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}amino}-N-hydroxy-2-(4-hydroxycyclohexyl)ethanamide;
- 15 (2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino}-N-hydroxy-2-(4-hydroxycyclohexyl)-ethanamide;
- 2-[(6-But-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-N-hydroxy-acetamide;
- 20 2-[[[4-{{[3-(4-Chlorophenyl)-2-propynyl]oxy}phenyl]sulfonyl}(methyl)amino]-N-hydroxyacetamide;
- N-Hydroxy-2-(methyl{{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino})acetamide;
- 25 2-[(4-But-2-ynylthiophenylsulfonyl)methylamino]-N-hydroxyacetamide;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-yl][4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxypropanamide;
- 30 1-[[{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-sulfonyl}(methyl)-amino]-N-hydroxycyclohexanecarboxamide;
- 1-[[{{[4-(2-Butynyloxy)phenyl]sulfonyl}(3-pyridinylmethyl)amino]N-hydroxycyclohexanecarboxamide;
- 35 1-([{{[4-(2-Butynyloxy)phenyl]sulfonyl}amino})-N-hydroxycyclohexanecarboxamide;
- 40 1-([{{[4-(2-Butynyloxy)phenyl]sulfonyl}amino})-N-hydroxycyclopentanecarboxamide;
- 2-([{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-3-methyl-3-[(2-(4-morpholinylethyl)sulfanyl]-butanamide hydrochloride;
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- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2-(4-methyl-1-ethyl-1-piperazinyl)ethyl]sulfanyl}butanamide;
- 5 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2-(diethylamino)ethyl]sulfanyl}butanamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2-(1-pyrrolidinyl)ethyl]sulfanyl}butanamide;
- 10 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2-(1H-imidazol-1-yl)ethyl]sulfanyl}butanamide;
- Methyl 1-[2-([2-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)]amino)-3-
(hydroxyamino)-1,1-dimethyl-3-oxopropyl]sulfanyl)ethyl]-2-pyrrolidine-
15 carboxylate;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
[(2(4-morpholinylpropyl)sulfanyl)-butanamide;
- 20 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2(4-methyl-1-ethyl-1-piperazinyl)propyl]sulfanyl}butanamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-
{[2-(diethylamino)propyl]sulfanyl}butanamide;
- 25 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-
methylsulfanyl-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-
30 ethylsulfanyl-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-
propylsulfanyl-butyramide;
- 35 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-
(pyridin-3-ylmethylsulfanyl)-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-
benzylsulfanyl-butyramide;
- 40 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-
(methylsulfanyl)-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(pyridin-3-
45 ylmethylsulfanyl)-butyramide;

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- 3-(Benzylthio)-2-[[[4-(2-butynyloxy)phenyl]sulfonyl]methylamino]-N-hydroxy-propanamide;
- 5 3-(Benzylthio)-2-[[[4-(2-butynyloxy)phenyl]sulfonyl]pyridin-3-ylmethylamino]-N-hydroxypropanamide;
- 2-[[[4-(2-Butynyloxy-phenyl)sulfonyl]amino]-N-hydroxy-3-methyl-(3-methylthio)-butyramide;
- 10 2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butylamide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butylamide;
- 15 2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-methyl-[(3-pyridinyl-methyl)thio] butylamide;
- 2-[(4-Butynyloxy-phenyl)sulfonyl]-amino]-N-hydroxy-3-methyl-(3-benzyl-sulfanyl) butylamide;
- 20 2-([4-(2-Butynyloxy)phenyl]sulfonyl) amino-N-hydroxy-3-{[(methyl-1H-imidazol-2-yl)methylsulfanyl]butylamide};
- 25 2-([4-(2-butynyloxy)phenyl]sulfonyl) amino-N-hydroxy-3-methyl-3-{[2-(4-morpholinyl) ethyl]sulfanyl}butylamide;
- tert*-Butyl{[2-([4-2-butynyloxy)phenyl]sulfonyl) amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl} acetate;
- 30 *tert*-Butyl {[2-([4-2-butynyloxy)phenyl]sulfonyl) amino)-3-(hydroxyamino)-1,1-dimethyl -3-oxopropyl}sulfanyl acetic acid, sodium salt;
- 2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-(methylthio)-propanamide;
- 35 2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(benzylthio)-propanamide;
- 40 2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(pyridinylthio)-propanamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl) amino)-N-hydroxy-3-[(Z)-11-tetradecenylsulfanyl]propanamide;
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- (2S)-2-(({4-(2-Butynyloxy)phenyl}sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanamide;
- 5 (2S)-2-(({4-(2-Butynyloxy)phenyl}sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-propanamide;
- (3S)-4-(({4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-1,4-thiazepane-3-carboxamide;
- 10 (3S)-4-(({4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide;
- (3S)-4-(({4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide 1,1-dioxide;
- 15 2-(({4-(2-Butynyloxy)phenyl}sulfonyl)amino)-N-hydroxy-2-(4-hydroxyphenyl)acetamide;
- 20 2-(({4-(2-Butynyloxy)phenyl}sulfonyl)amino)-N-hydroxy-2-[4-(2-propynyloxy)phenyl]acetamide;
- 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-N-hydroxy-2-(4-methoxyphenyl)acetamide;
- 25 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide;
- tert*-Butyl 2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl(methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate;
- 30 2-[4-(2-Aminoethoxy)phenyl]-2-[4-(2-butynyloxy)phenyl]sulfonyl(methylamino)-N-hydroxyacetamide;
- 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-2-{4-[2-(dimethylamino)ethoxy]phenyl}-N-hydroxyacetamide;
- 35 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- 40 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-N-hydroxy-2-{4-[2-(2-oxo-1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl(methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-1-piperazinecarboxylate;
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- 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-{4-[2-(1-piperazinyl)ethoxy]phenyl}acetamide;
- 5 *tert*-Butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 2-[4-(3-Aminopropoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]-sulfonyl](methylamino)-N-hydroxyacetamide;
- 10 *tert*-Butyl (3*S*)-3-{4-[(1*R*)-1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}-1-pyrrolidine-carboxylate;
- 15 (2*R*)-2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-{4-[(3*S*)-pyrrolidinyl]phenyl}ethanamide;
- tert*-Butyl (2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-(methyl)carbamate;
- 20 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide;
- Ethyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 25 2-{4-[3-(Acetylaminopropoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]-sulfonyl](methylamino)-N-hydroxyacetamide;
- Butyl-3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 30 Benzyl-3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 35 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-(4-{3-[(methylsulfonyl)amino]propoxy}phenyl)acetamide;
- 2-(4-{3-[(Anilinocarbonyl)amino]propoxy}phenyl)-2-[[4-(2-butynyloxy)-phenyl]sulfonyl](methylamino)-N-hydroxyacetamide;
- 40 *tert*-Butyl 2-{4-[(1*R*)-1-[[4-(2-butynyloxy)phenyl]sulfonyl]amino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate;
- (2*R*)-2-[4-(2-Aminoethoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]-sulfonyl]-amino)-N-hydroxyethanamide;
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- (2R)-2-{4-[2-(Acetylamino)ethoxy]phenyl}-2-([4-(2-butynyloxy)phenyl]-sulfonyl)amino)-N-hydroxyethanamide;
- 5 *tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-1-piperazinecarboxylate;
- tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-(methyl)carbamate;
- 10 2-{[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- 15 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino){4-[2-(dimethylamino)ethoxy]-phenyl}-N-hydroxyacetamide;
- 20 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-methyl-1,3-thiazol-5-yl)ethoxy]phenyl}acetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-(4-{2-[2-(2-thoxyethoxy)ethoxy]ethoxy}phenyl)acetamide;
- 25 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(2-methoxyethoxy)ethoxy]phenyl}acetamide;
- 30 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-2-phenylacetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-2-(4-chlorophenyl)-N-hydroxyacetamide;
- 35 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-5-[(4-chlorophenyl)-sulfonyl]-N-hydroxypentanamide;
- 40 1-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 45 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-

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- diethylamide 3-hydroxyamide;
- 5 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(pyrrolidine-1-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diisopropylamide 3-hydroxyamide;
- 10 Benzyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-3-[(hydroxyamino)carbonyl]-1-piperazinecarboxylate;
- 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 3-hydroxyamide 1-(methyl-phenyl-amide);
- 15 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-3-hydroxy-N-1-(4-methoxyphenyl)-1,3- piperazinedicarboxamide;
- 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-1-(4-fluorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide;
- 20 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-1-(3,5-dichlorophenyl)-N-3-hydroxy-1,3- piperazinedicarboxamide;
- 4-Acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 25 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-propionyl-piperazine-2-carboxylic acid hydroxyamide;
- 30 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(thiophene-2-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methanesulfonyl-piperazine-2-carboxylic acid hydroxyamide;
- 35 4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid methyl ester;
- {2-[4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazin-1-yl]-2-oxo-ethyl}-carbamic acid *tert*-butyl ester;
- 40 4-Aminoacetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 45 1-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-4-[(2,2,5-trimethyl-1,3-dioxan-5-yl)carbonyl]-2-piperazinecarboxamide;

- 1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-4-[3-hydroxy-2-(hydroxymethyl)-2-methylpropanoyl-2-piperazinecarboxamide;
- 5 4-(4-Bromo-benzyl)-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-pyridin-3-ylmethyl-piperazine-2-carboxylic acid hydroxyamide;
- 10 (3S)-4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 9-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-6-thia-9-azaspiro[4,5]-decane-10-carboxamide;
- 15 9-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4-azaspiro[5,5]-undecane-5-carboxamide;
- 20 4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-2,2-diethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-thiomorpholine-3-carboxamide;
- 25 4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-3-morpholinecarboxamide;
- 9-Benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide;
- 30 9-Methyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide;
- N-Hydroxy-2,2-dimethyl-4-[(4-{{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl]sulfonyl]-3-thiomorpholine carboxamide;
- 35 N-Hydroxy-4-({4-[(5-hydroxy-2-pentynyl)oxy]phenyl} sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 40 *tert*-Butyl 5-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl} sulfonyl)phenoxy]-3-pentynylcarbamate;
- 4-({4-[(5-Amino-2-pentynyl)oxy]phenyl} sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
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- 4-[(4-{[4-(Benzyloxy)-2-butynyl]oxy}phenyl)sulfonyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 5 N-Hydroxy-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide;
- N-Hydroxy-4-({4-[(6-hydroxy-2-hexynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 10 *tert*-Butyl 6-[4-({(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-4-hexynylcarbamate;
- (3S)-4-({4-[(6-Amino-2-hexynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 15 *tert*-Butyl 7-[4-({(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-5-heptynylcarbamate;
- (3S)-4-({4-[(7-Amino-2-heptynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 20 (3S)-N-Hydroxy-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]-phenyl}sulfonyl)-3-thiomorpholine carboxamide;
- 25 (3S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide (1S)-oxide;
- (3S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide (1R)-oxide;
- 30 (3S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1,1-dioxide;
- (3S)-N-Hydroxy-2,2-dimethyl-4-{[4-(2-propynyloxy)phenyl]sulfonyl}-3-thiomorpholine carboxamide;
- 35 (3S)-N-Hydroxy-2,2-dimethyl-4-{[4-(2-pentynyloxy)phenyl]sulfonyl}-3-thiomorpholine carboxamide;
- 40 (3S)-N-Hydroxy-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 45 4-[4-({(3S)-3-[(Hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-2-butynyl acetate;

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- (3S)-N-Hydroxy-4-({4-[(6-hydroxy-2,4-hexadiynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 5 (3S)-N-Hydroxy-2,2-dimethyl-4-{[4-(2,4-pentadiynyloxy)phenyl]sulfonyl}-3-thiomorpholine carboxamide;
- (3S)-4-({4-[(4-Fluoro-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 10 4-({4-[(4-Amino-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- tert*-Butyl 4-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}-sulfonyl)phenoxy]-2-butynylcarbamate;
- 15 *tert*-Butyl 4-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}-sulfonyl)phenoxy]-2-butynyl(methyl)carbamate;
- 20 7-[4-({(3S)-3-[(Hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}-sulfonyl)phenoxy]-5-heptynyl acetate;
- (3S)-N-Hydroxy-4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 25 (3S,5S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide;
- (3S,5R)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide;
- 30 (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,6-trimethyl-3-thiomorpholinecarboxamide;
- tert*-Butyl{(2R,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)-carbonyl]-6,6-dimethylthiomorpholinyl}methylcarbamate;
- 35 *tert*-Butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)-carbonyl]-6,6-dimethylthiomorpholinyl}methylcarbamate;
- 40 (3S,6R)-Trans-6-(aminomethyl)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride;
- (3S,6S)-Cis-6-(aminomethyl)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride;
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- tert*-Butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)-carbonyl]-6,6-dimethylthiomorpholinyl}acetate;
- 5 {(2S,5S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl}acetic acid;
- (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-6-[2-(hydroxyamino)-2-oxoethyl]-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 10 (3S,6S)-6-(2-Amino-2-oxoethyl)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-[2-(dimethylamino)-2-oxoethyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 15 (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide;
- (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-methyl-1-piperazinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide hydrochloride;
- 20 (3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-(2-{[2-(dimethylamino)-ethyl]amino}-2-oxoethyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 25 Methyl (3S,6S)-6-{{{*tert*-butoxycarbonyl}amino}methyl}-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate;
- 30 (4S)-3-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-5,5-dimethyl-1,3-thiazolidine-4-carboxamide;
- tert*-Butyl 4-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-4-[(hydroxyamino)-carbonyl]-1-piperidinecarboxylate;
- 35 4-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-4-piperidinecarboxamide;
- 1-Benzoyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
- 40 1-Benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
- 45 *tert*-Butyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-1,4-diazepane-1-carboxylate;

- 4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
5 4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-methyl-1,4-diazepane-5-carboxamide;
4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-thiazepine-5-carboxamide;
10 (2R)-5-(Acetylamino)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]thiophene-2-carboxamide;
15 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{{(ethylamino)carbonyl}amino}-N-hydroxypentanamide;
(2R)-5-[(Anilino)carbonyl]amino)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
20 Octyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
4-Methoxyphenyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
25 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{{(diethylamino)carbonyl}amino}-N-hydroxypentanamide;
(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{{[(methylanilino)carbonyl]amino}pentanamide;
30 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{{[(1-methyl-1H-imidazol-4-yl)sulfonyl]amino}pentanamide;
35 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-[(2-morpholin-4-ylacetyl)amino]pentanamide;
(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{{[2-(4-methylpiperazin-1-yl)acetyl]amino}pentanamide;
40 (2R)-5-{{[2-(Benzylamino)acetyl]amino}-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
45 (3S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxamide;

- (2R)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-5-[(imino-{[(4-{[(4-methoxy-2,3,6-trimethylphenyl)sulfonyl] amino} methyl) amino]}-pentanamide;
- (2R)-2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-guanidino-pentanoic acid hydroxyamide;
- (2R)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-5-[(imino{[(4-methylphenyl)sulfonyl] amino} methyl) amino]pentanamide;
- (3R)-3-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-4-(hydroxyamino)-4-oxobutanoic acid;
- (2S)-3-(*tert*-Butylthio)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxypropanamide;
- (2S)-3-([(Acetylamino)methyl]thio)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}-amino)-N-hydroxypropanamide;
- (2S)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-3-[(4-methylbenzyl)thio]propanamide;
- (2S)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-3-[(4-methoxybenzyl)thio]propanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxypentanediamide;
- (4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentanoic acid;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-4-phenylbutanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-3-(1H-imidazol-5-yl)propanamide;
- (2R,4S)-1-{[4-(But-2-ynyloxy)phenyl]sulfonyl}-N,4-dihydroxypyrrolidine-2-carboxamide;
- (2R)-6-Amino-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxyhexanamide;
- Benzyl (5R)-5-({[4-(but-2-ynyloxy)phenyl]sulfonyl} amino)-6-(hydroxyamino)-6-oxohexylcarbamate;

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- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxy-3-(1-naphthyl)-propanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxy-3-(2-naphthyl)-propanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxyhexanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxypentanamide;
- (2R)-5-Amino-2-([4-(but-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxypentanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-3-(3,4-difluorophenyl)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-3-(4-fluorophenyl)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxy-3-(4-nitrophenyl)-propanamide;
- (2R)-1-([4-(But-2-ynyloxy)phenyl]sulfonyl)-N-hydroxypiperidine-2-carboxamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N,3-dihydroxypropanamide;
- (2R)-3-(Benzyloxy)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxy-3-thien-2-ylpropanamide;
- (2R,3S)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl amino)-N,3-dihydroxybutanamide;
- (2R,3S)-3-(Benzyloxy)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl amino)-N-hydroxybutanamide;
- (4S)-3-([4-(But-2-ynyloxy)phenyl]sulfonyl)-N-hydroxy-1,3-thiazolidine-4-carboxamide;
- (3R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)-N-hydroxy-1,2,3,4-tetrahydroisoquinoline-3-carboxamide;
- (2R)-3-[4-(Benzyloxy)phenyl]-2-([4-(but-2-ynyloxy)phenyl]sulfonyl amino)-N-

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hydroxypropanamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-2-phenylethanamide;

(2R)-5-(Acetylamino)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-pentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]-1H-benzimidazole-5-carboxamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]benzamide;

4-Bromo-N-[(4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]benzamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(butyrylamino)-N-hydroxypentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]-3-chlorothiophene-2-carboxamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]-4-chlorobenzamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]cyclohexanecarboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-{[2-(3,4-dichlorophenyl)acetyl]amino}-N-hydroxypentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]-2,5-dimethyl-3-furamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]-3,5-dimethylisoxazole-4-carboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-N-hydroxy-5-[(3-phenylpropanoyl)amino]pentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]isonicotinamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-oxopentyl]nicotinamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl} amino)-5-(hydroxyamino)-5-

- oxopentyl]-2-methoxybenzamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]-4-methoxybenzamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-{[2-(4-nitrophenyl)acetyl]amino}pentanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-[(2-phenylacetyl)amino]pentanamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]quinoline-3-carboxamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]thiophene-3-carboxamide;
- (E)-N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]-3-phenylprop-2-enamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-1H-benzimidazole-5-carboxamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]benzamide;
- 4-Bromo-N-[(5R)-5-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]benzamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-3-chlorothiophene-2-carboxamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-4-chlorobenzamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]cyclohexanecarboxamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-6-{[2-(3,4-dichlorophenyl)acetyl]amino}-N-hydroxyhexanamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-2,5-dimethyl-3-furamide;
- N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-3,5-dimethylisoxazole-4-carboxamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-6-[(3-phenyl-

- propanoyl)amino]hexanamide;
- N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]isonicotinamide;
- N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-2-methoxybenzamide;
- N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-4-methoxybenzamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-6-{[2-(4-nitrophenyl)acetyl]amino}hexanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-6-[(2-phenylacetyl)amino]hexanamide;
- N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]quinoline-3-carboxamide;
- N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]thiophene-3-carboxamide;
- (E)-N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-3-phenylprop-2-enamide;
- (Z)-N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]octadec-9-enamide;
- N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]thiophene-2-carboxamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{{(ethylamino)carbonyl}amino}-N-hydroxypentanamide;
- (2R)-5-[(Anilinocarbonyl)amino]-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
- Octyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
- 4-Methoxyphenyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{{(diethylamino)carbonyl}amino}-N-hydroxypentanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-

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{[(methylanilino)carbonyl]amino}pentanamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{{(1-methyl-1H-imidazol-4-yl)sulfonyl}amino}pentanamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-[(2-morpholin-4-ylacetyl)amino]pentanamide;

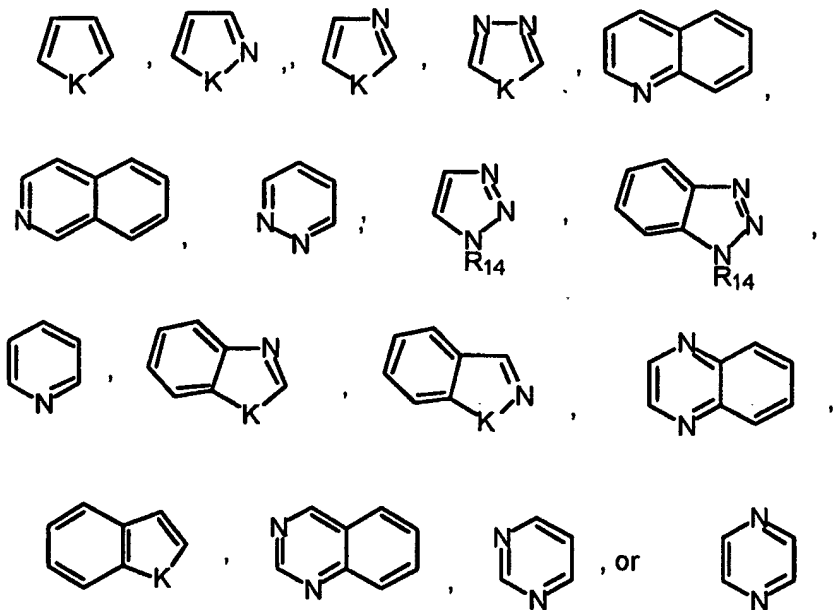
(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{{2-(4-methylpiperazin-1-yl)acetyl}amino}pentanamide; and

(2R)-5-{{2-(Benzylamino)acetyl}amino}-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}; N-hydroxypentanamide;

or a pharmaceutical salt thereof.

Heteroaryl, as used throughout, is a 5-10 membered mono- or bicyclic ring having from 1-3 heteroatoms selected from N, NR₁₄, S and O. Heteroaryl is

5 preferably



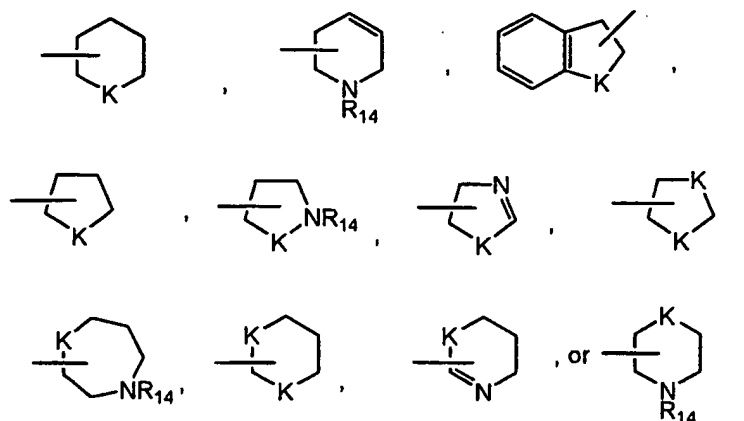
wherein K is O, S or -NR₁₄ and R₁₄ is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, or cycloalkyl of 3-6 carbon atoms. Preferred heteroaryl rings include

10 pyrrole, furan, thiophene, pyridine, pyrimidine, pyridazine, pyrazine, triazole, pyrazole, imidazole, isothiazole, thiazole, isoxazole, oxazole, indole, isoindole, benzofuran, benzothiophene, quinoline, isoquinoline, quinoxaline, quinazoline,

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benzotriazole, indazole, benzimidazole, benzothiazole, benzisoxazole, and benzoxazole. Heteroaryl groups may optionally be mono or di substituted.

5 C4-C8 cycloheteroalkyl as used herein refers to a 5 to 9 membered saturated or unsaturated mono or bi-cyclic ring having 1 or 2 heteroatoms selected from N, NR₁₄, S or O. Heterocycloalkyl rings of the present invention are preferably selected from;



10 wherein K is NR₁₄, O or S and R₁₄ is a bond, hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, or cycloalkyl of 3-6 carbon atoms.

Preferred heterocycloalkyl rings include piperidine, piperazine, morpholine, tetrahydropyran, tetrahydrofuran or pyrrolidine.

15 Cycloheteroalkyl groups of the present invention may optionally be mono- or di- substituted.

Aryl, as used herein refers to a phenyl or naphthyl rings which may, optionally be mono-, di- or tri-substituted.

20 Alkyl, alkenyl, alkynyl, and perfluoroalkyl include both straight chain as well as branched moieties. Alkyl, alkenyl, alkynyl, and cycloalkyl groups may be unsubstituted (carbons bonded to hydrogen, or other carbons in the chain or ring) or may be mono- or poly-substituted. Lower alkyl moieties contain from 1 to 6 carbon atoms.

25

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Aralkyl as used herein refers to a substituted alkyl group, -alkyl-aryl, wherein alkyl is lower alkyl and preferably from 1 to 3 carbon atoms, and aryl is as previously defined.

5 Heteroaralkyl as used herein refers to a substituted alkyl group, alkyl-heteroaryl wherein alkyl is lower alkyl and preferably from 1 to 3 carbon atoms, and heteroaryl is as previously defined.

Halogen means bromine, chlorine, fluorine, and iodine.

Suitable substituents of aryl, aralkyl, heteroaryl, heteroaralkyl, alkyl, alkenyl,
 10 alkynyl, and cycloalkyl include, but are not limited to hydrogen, halogen, alkyl of 1-6 carbon atoms; alkenyl of 2-6 carbon atoms; alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, -OR₈,
 -[[O(CH₂)_p]_q]-OCH₃, CN, -COR₈, perfluoroalkyl of 1-4 carbon atoms, -O-perfluoroalkyl of 1-4 carbon atoms, -CONR₈R₉, -S(O)_nR₈,
 15 -S(O)_nR₁₈C(O)OR₈, -S(O)_nR₁₈OR₉, -S(O)_nR₁₈NR₈R₉,
 -S(O)_nR₁₈NR₈R₉COOR₈, -S(O)_nR₁₈NR₈COR₉, -OPO(OR₈)OR₉,
 -PO(OR₈)R₉, -OC(O)NR₈R₉, -C(O)NR₈OR₉, -C(O)R₁₈NR₈R₉,
 -COOR₈, -SO₃H, -NR₈R₉, -N[(CH₂)₂]₂NR₈, -NR₈COR₉,
 -NR₈C(O)CH=CHaryl, -NR₈C(O)(CH₂)_nNR₈R₉,
 20 -NR₈C(O)CH₂NHCH₂aryl, NR₈C(O)R₁₈, -NR₈COOR₉, -SO₂NR₈R₉,
 -NO₂, -N(R₈)SO₂R₉, -NR₈CONR₈R₉, -NR₈C(=NR₉)NR₈R₉,
 -NR₈C(=NR₉)N(SO₂R₈)R₉, NR₈C(=NR₉)N(C=OR₈)R₉, -tetrazol-5-yl,
 -SO₂NHCN, -SO₂NHCONR₈R₉, -(OR₁₈)NR₈S(O)R₉, -(OR₁₈)NR₈C(O)R₉,
 -(OR₁₈)NR₈C(O)NR₈R₉, -(OR₁₈)NR₈COOR₉, -(OR₁₈)NR₈R₉, phenyl,
 25 heteroaryl, or -C₄-C₈-cycloheteroalkyl;

wherein -NR₈R₉ may form a heterocyclic group as previously defined, such as pyrrolidine, piperidine, morpholine, thiomorpholine, oxazolidine, thiazolidine, pyrazolidine, piperazine, and azetidine ring; p is 1 or 2, q is 1 through 3 and

30 R₁₈ is alkyl of 1-20 carbon atoms.

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In some preferred embodiments of the present invention R8 and R18 may be further substituted with halogen, C1-C3 alkyl, C1-C3 alkoxy and OH, and NO₂.

When a moiety contains more than substituent with the same designation (i.e., phenyl tri-substituted with R₁) each of those substituents (R₁ in this case) may be the same or different.

Pharmaceutically acceptable salts can be formed from organic and inorganic acids, for example, acetic, propionic, lactic, citric, tartaric, succinic, fumaric, maleic, malonic, mandelic, malic, phthalic, hydrochloric, hydrobromic, phosphoric, nitric, sulfuric, methanesulfonic, naphthalenesulfonic, benzenesulfonic, toluenesulfonic, camphorsulfonic, and similarly known acceptable acids when a compound of this invention contains a basic moiety. Salts may also be formed from organic and inorganic bases, preferably alkali metal salts, for example, sodium, lithium, or potassium, when a compound of this invention contains an acidic moiety.

The compounds of this invention may contain an asymmetric carbon atom and some of the compounds of this invention may contain one or more asymmetric centers and may thus give rise to optical isomers and diastereomers. While shown without respect to stereochemistry, the present invention includes such optical isomers and diastereomers; as well as the racemic and resolved, enantiomerically pure R and S stereoisomers; as well as other mixtures of the R and S stereoisomers and pharmaceutically acceptable salts thereof. It is recognized that one optical isomer, including diastereomer and enantiomer, or stereoisomer may have favorable properties over the other. Thus when disclosing and claiming the invention, when one racemic mixture is disclosed, it is clearly contemplated that both optical isomers, including diastereomers and enantiomers, or stereoisomers substantially free of the other are disclosed and claimed as well.

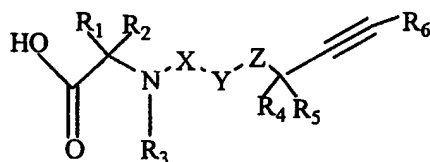
The compounds of this invention are shown to inhibit the enzymes MMP-1, MMP-9, MMP-13 and TNF- α converting enzyme (TACE) and are therefore useful in the treatment of arthritis, tumor metastasis, tissue ulceration, abnormal wound healing, periodontal disease, graft rejection, insulin resistance, bone disease and HIV infection. In particular, the compounds of the invention provide enhanced levels of inhibition of the activity of TACE in vitro and in cellular assay and/or enhanced

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selectivity over MMP-1 and are thus particularly useful in the treatment of diseases mediated by TNF.

Accordingly this invention provides a process for preparing compounds of
5 formula B, as defined above, which comprises one of the following:

a) reacting a compound of formula V:

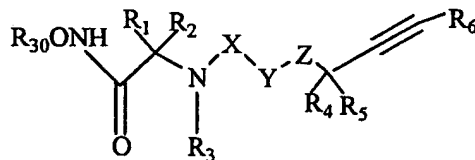


(V)

10 wherein R_1 , R_2 , R_3 , R_4 , R_6 , X, Y and Z are defined above, or a reactive derivative thereof, with hydroxylamine to give a corresponding compound of formula B;

or

b) deprotecting a compound of formula VI:



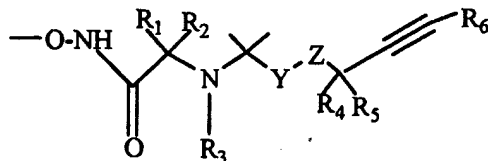
(VI)

15

wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , X, Y and Z are defined above, and R_{30} is a suitable protecting group such as t-butyl, benzyl, and trialkylsilyl, to give a corresponding compound of formula B

or

20 c) cleaving a resin supported hydroxamate derivative containing the group



to give a compound of formula B;

or

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d) resolving a mixture (e.g. racemate) of optically active isomers of a compound of formula **B** to isolate one enantiomer or diastereomer substantially free of the other enantiomer or diastereomers;

or

5 e) acidifying a basic compound of formula **B** with a pharmaceutically acceptable acid to give a pharmaceutically acceptable salt;

or

f) converting a compound of formula **B** having a reactive substituent group or site to give a compound of formula **B** having a different substituent group or site.

10

With regards to process a) the reaction can be carried out by processes known in the art, e.g. by reaction of an acid chloride reactive derivative with the hydroxylamine.

15 Removal of protecting groups, as illustrated by process b) can be carried out by processes known in the art to provide the hydroxamic acid.

Process c) may be carried out as described herein with reference to Scheme 10 e.g. using a strong acid such as TFA to cleave the hydroxamate from the resin.

20

With regard to process d) standard separation techniques may be used to isolate particular enantiomeric or diastereomeric forms. For example a racemic mixture may be converted to a mixture of optically active diastereoisomers by reaction with a single enantiomer of a 'resolving agent' (for example by diastereomeric salt formation or formation of a covalent bond). The resulting mixture of optically active diastereoisomers may be separated by standard techniques (e.g. crystallisation or chromatography) and individual optically active diastereoisomers then treated to remove the 'resolving agent' thereby releasing the single enantiomer of the compound of the invention. Chiral chromatography (using a chiral support, eluent or ion pairing agent) may also be used to separate enantiomeric mixtures directly.

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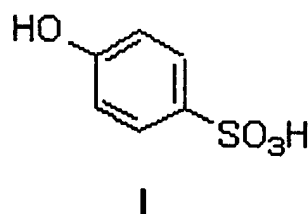
The compounds of formula **B** may be isolated in the form of a salt of a pharmaceutically acceptable acid e.g. an organic or inorganic acid by treatment with an acid such as described above.

5

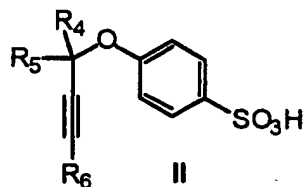
With regard to process e) compounds of formula **B** having a reactive substituent group or site such as hydroxy or amino can be converted to other compounds of formula **B** in known manner e.g. alcohol to ester or ether. Reactive sites such as a sulfur atom (as shown in Scheme 21) can be oxidized to SO or SO₂. If
10 necessary reacting substituent groups may be protected during the synthesis of compounds of formula **B** and removed as a last step – see Schemes 26 and 27

The invention is further directed to a process for making compounds of structure **B** involving one or more reactions as follows:

15 1) alkylating a compound of formula **I**, or a salt or solvate thereof,



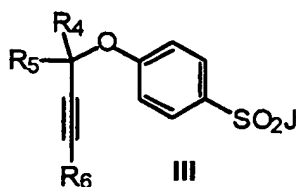
into a compound of formula **II**



20

2) reacting a compound of formula **II** above, or a salt or solvate thereof, with a chlorinating agent such as thionyl chloride, chlorosulfonic acid, oxalyl chloride, phosphorus pentachloride, or other halogenating agents such as fluorosulfonic acid or
25 thionyl bromide to a compound of formula **III**:

-36-

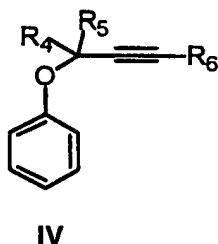


wherein J is fluorine, bromine, chlorine.

The resultant sulfonyl chloride, fluoride or bromide, may be further converted into triazolide, imidazolide or benzothiazolide derivatives, where J is 1,2,4-triazolyl, benzotriazolyl or imidazol-yl, by reacting the compound with 1,2,4-triazole, imidazole or benzotriazole, respectively. R₄, R₅ and R₆ are as defined above.

The invention is still further directed to a process for making compounds of structure **B** involving one or more reactions as follows:

1) alkylating phenol, or a salt or solvate thereof, into a compound of formula **IV**:



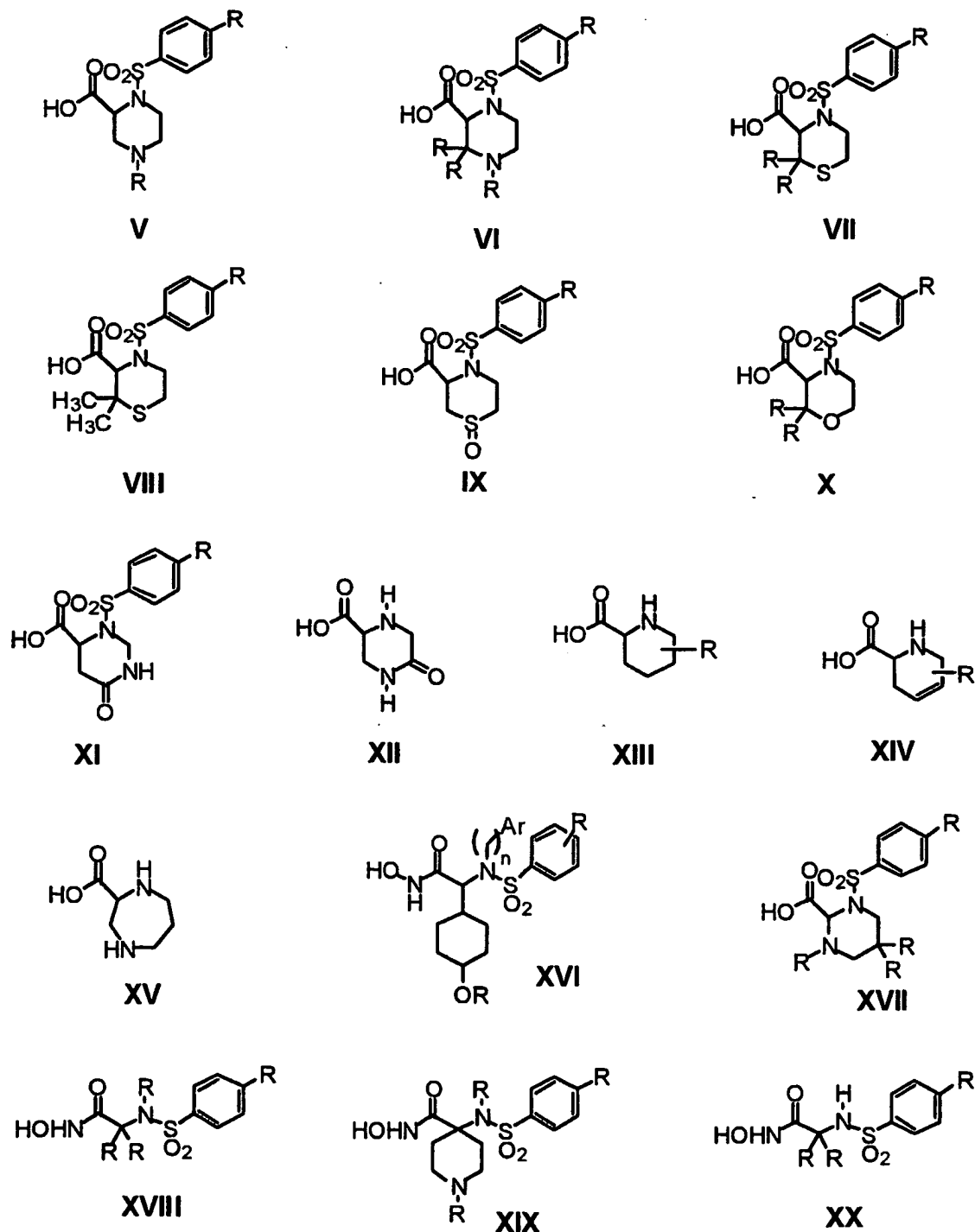
2) reacting a compound of formula **IV** above, or a salt or solvate thereof with chlorosulfonic acid to prepare a compound of formula **II** above.

Particularly preferred intermediates are compounds of formulae **II** and **III**, with the proviso that R₆ is not hydrogen.

Compounds of the present invention are prepared using conventional techniques known to those skilled in the art of organic synthesis. The starting materials used in preparing the compounds of the invention are known, made by known methods or are commercially available.

Compounds of the following general structures (Figure 1; V-XX), and the methods used to prepare them, are known and references are given herein below.

Figure 1:



Compounds V-XII :

a) U. S. Patent 5,753,653.

5 b) Kogami, Yuji; Okawa, Kenji. *Bull. Chem. Soc. Jpn.* **1987**, 60(8), 2963.

Compound XII:

Auvin, S.; Cochet, O.; Kucharczyk, N.; Le Goffic, F.; Badet, B. *Bioorganic Chemistry*, **1991**, *19*, 143.

Compounds XIII-XIV:

- 5 a) Angle, S. R.; Breitenbucher, J. G.; Arnaiz, D. O. *J. Org. Chem.* **1992**, *57*, 5947.
b) Asher, Vikram; Becu, Christian; Anteunis, Marc J. O.; Callens, Roland *Tetrahedron Lett.* **1981**, *22*(2), 141.

Compounds XV:

- Levin, J. I.; DiJoseph, J. F.; Killar, L. M.; Sung, A.; Walter, T.; Sharr, M. A.; Roth,
10 C. E.; Skotnicki, J. S.; Albright, J. D. *Bioorg. & Med. Chem. Lett.* **1998**, *8*, 2657.

Compounds XVI:

U. S. Patent 5,770,624

Compounds XVII:

- Pikul, S.; McDow Dunham, K. L.; Almstead, N. G.; De, B.; Natchus, M. G.;
15 Anastasio, M. V.; McPhail, S. J.; Snider, C. E.; Taiwo, Y. O.; Rydel, T.; Dunaway,
C. M.; Gu, F.; Mieling, G. E. *J. Med. Chem.* **1998**, *41*, 3568.

Compounds XVIII:

U. S. Patents 5,455,258, 5,506,242, 5,552,419 and 5,770,624

MacPherson, *et. al.* in *J. Med. Chem.*, **1997**, *40*, 2525.

20 Compounds XIX:

U. S. Patents 5,455,258 and 5,552,419

Compounds XX:

U. S. Patent 5,804,593

- Tamura, *et. al.* in *J. Med. Chem.* **1998**, *41*, 640.
25

Those skilled in the art will recognize that certain reactions are best carried out when other potentially reactive functionality on the molecule is masked or protected, thus avoiding undesirable side reactions and/or increasing the yield of the reaction. To this end, those skilled in the art may use protecting groups. Examples of
30 these protecting group moieties may be found in T. W. Greene, P. G. M. Wuts "Protective Groups in Organic Synthesis", 2nd Edition, 1991, Wiley & Sons, New York. Reactive side chain functionalities on amino acid starting materials are

-39-

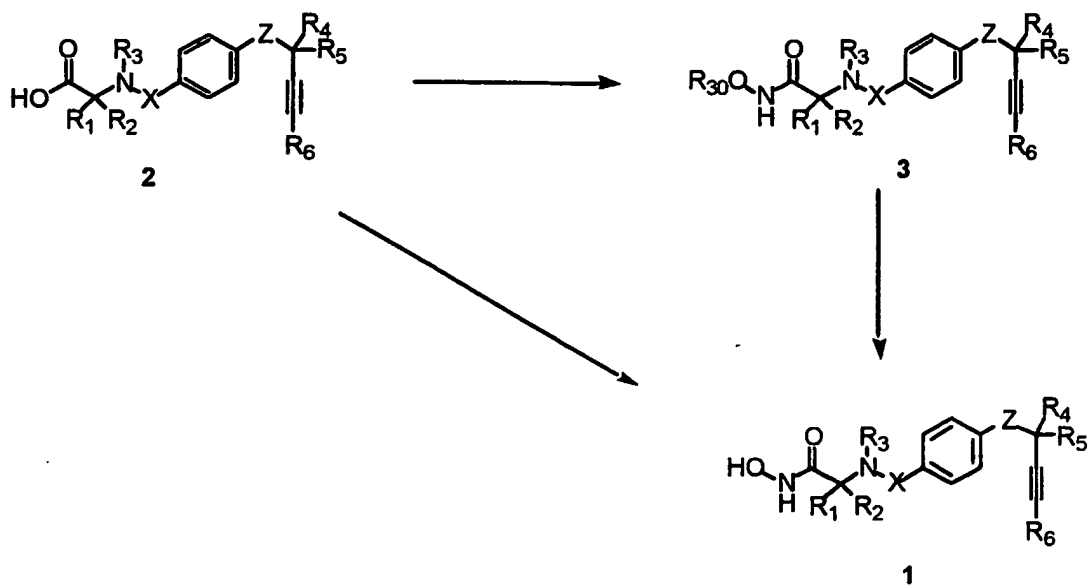
preferably protected. The need and choice of protecting groups for a particular reaction is known to those skilled in the art and depends on the nature of the functional group to be protected (hydroxy, amino, carboxy, etc.), the structure and stability of the molecule of which the substituent is part and the reaction conditions.

5 When preparing or elaborating compounds of the invention containing heterocyclic rings, those skilled in the art recognize that substituents on that ring may be prepared before, after or concomitant with construction of the ring. For clarity, substituents on such rings have been omitted from the schemes herein below.

Those skilled in the art will recognize that the nature and order of the
10 synthetic steps presented may be varied for the purpose of optimizing the formation of the compounds of the invention.

The hydroxamic acid compounds of the invention, **1**, are prepared according to **Scheme 1** by converting a carboxylic acid, **2**, into the corresponding acid chloride or anhydride, or by reacting it with a suitable peptide coupling reagent, followed by
15 reaction with hydroxylamine to give **1**, or with a protected hydroxylamine derivative to give **3**. Compounds **3**, wherein R_{30} is a t-butyl, benzyl, trialkylsilyl or other suitable masking group may then be deprotected by known methods to provide the hydroxamic acid **1**.

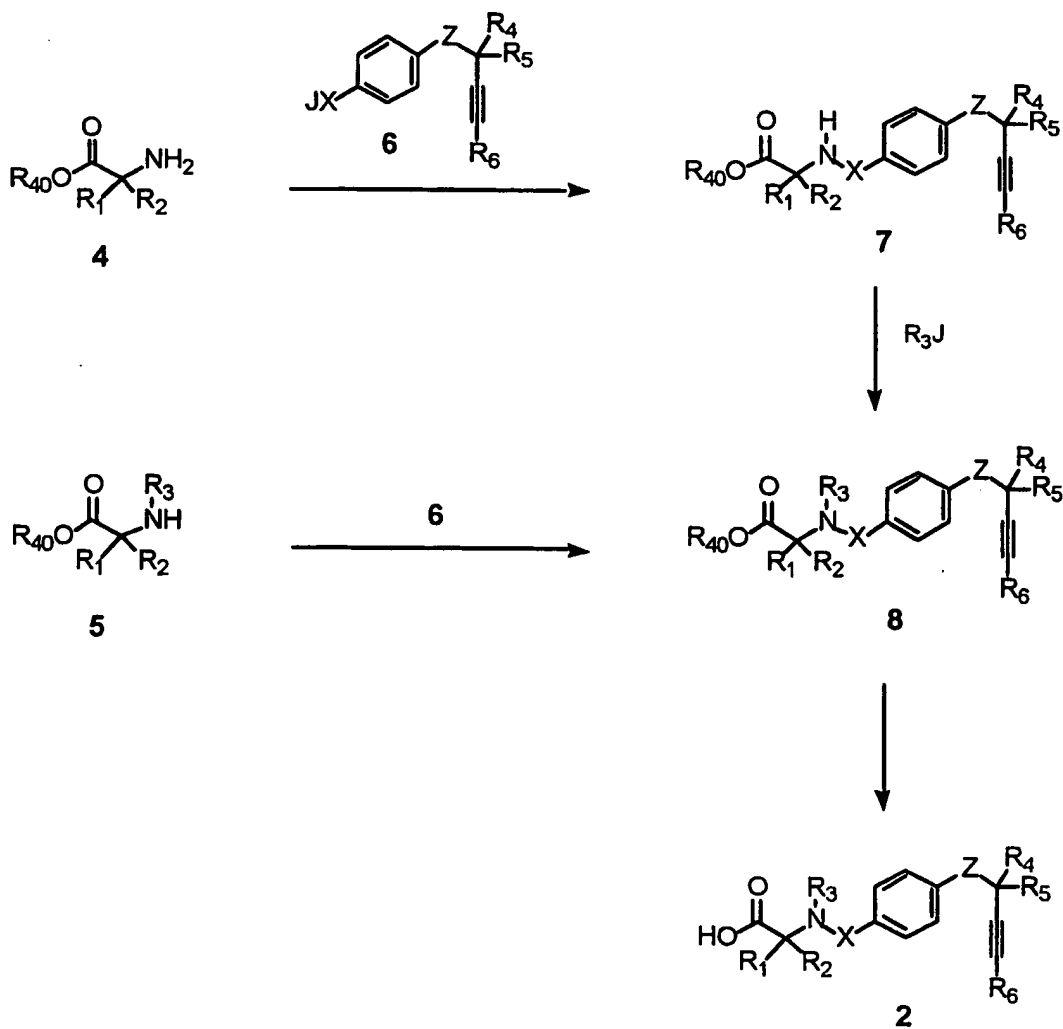
Scheme 1:



-40-

Carboxylic acids **2** may be prepared as shown in **Scheme 2**. Amino acid derivative **4**, in which R_{40} is hydrogen or a suitable carboxylic acid protecting group, may be sulfonylated or phosphorylated by reacting with compounds **6**, in which J is a suitable leaving group including, but not limited to chlorine. The N-H compound **7** may then be alkylated with R_3J and a base such as potassium carbonate or sodium hydride in a polar aprotic solvent such as acetone, N,N-dimethylformamide (DMF), or tetrahydrofuran (THF) to provide sulfonamide **8**. Compound **8** is also available through direct reaction of **6** with an N-substituted amino acid derivative, **5**. Conversion of **8** into the carboxylic acid is performed by acid, base hydrolysis, or other method consistent with the choice of protecting group R_{40} and the presence of a carbon-carbon triple bond.

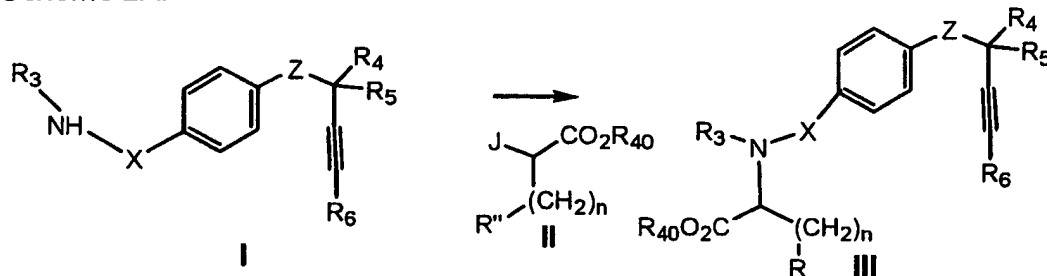
Scheme 2:



-41-

Compounds of formula 2 are also available without starting from an amino acid derivative 4. As shown in **Scheme 2A**, a compound of formula **I** is reacted with a compound of formula **II** (J is bromo or chloro, n is equal to 0 to 3, and R'' is phenyl, substituted phenyl or arylthio) in the presence of an acid scavenger such as ethyldiisopropylamine, potassium carbonate, sodium carbonate, sodium diisopropylamide in a solvent such as isopropyl alcohol, acetonitrile, N,N-dimethylformamide in the temperature range 0° to 100°C to give a compound of formula **III**, equivalent to compound 8.

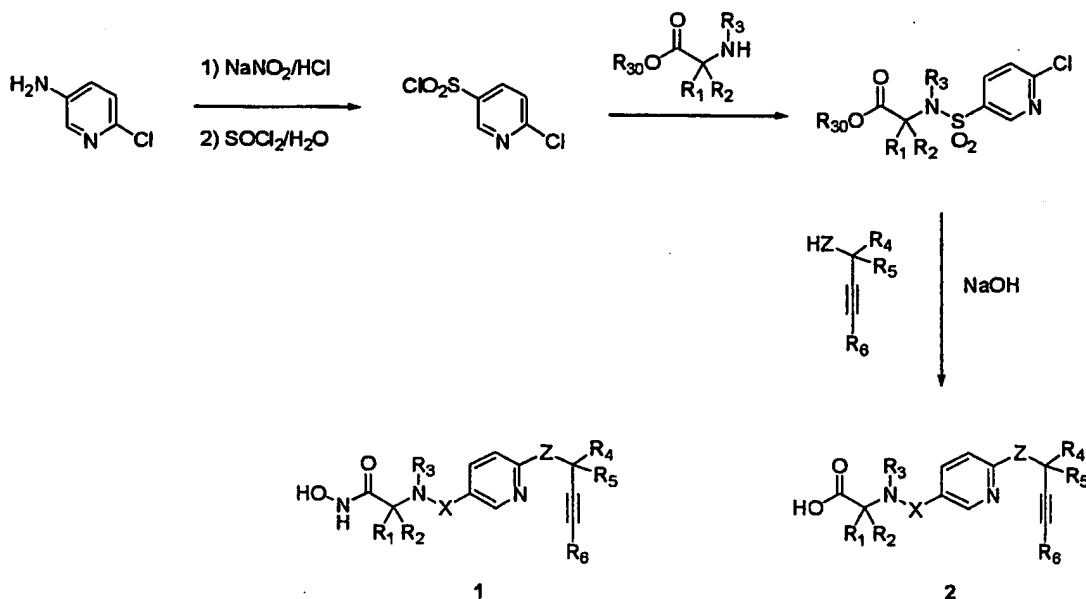
Scheme 2A:



Compounds 1 of the invention containing a heteroaryl sulfonamide may be prepared as shown in **Scheme 2B**. The 6-chloropyridine 3-sulfonyl chloride is available from the corresponding amino-pyridine. Sulfonylation of the appropriate amino acid with this pyridyl sulfonyl chloride then provides the 6-chloropyridine sulfonamide. Base mediated displacement of the chloro substituent of the 6-chloropyridine sulfonamide with the desired propargylic alcohol, amine or thiol with concomitant ester hydrolysis gives carboxylic acid 2. Conversion of the acid into the corresponding hydroxamic acid as described in **Scheme 1** then gives the pyridyl sulfonamide 1.

-42-

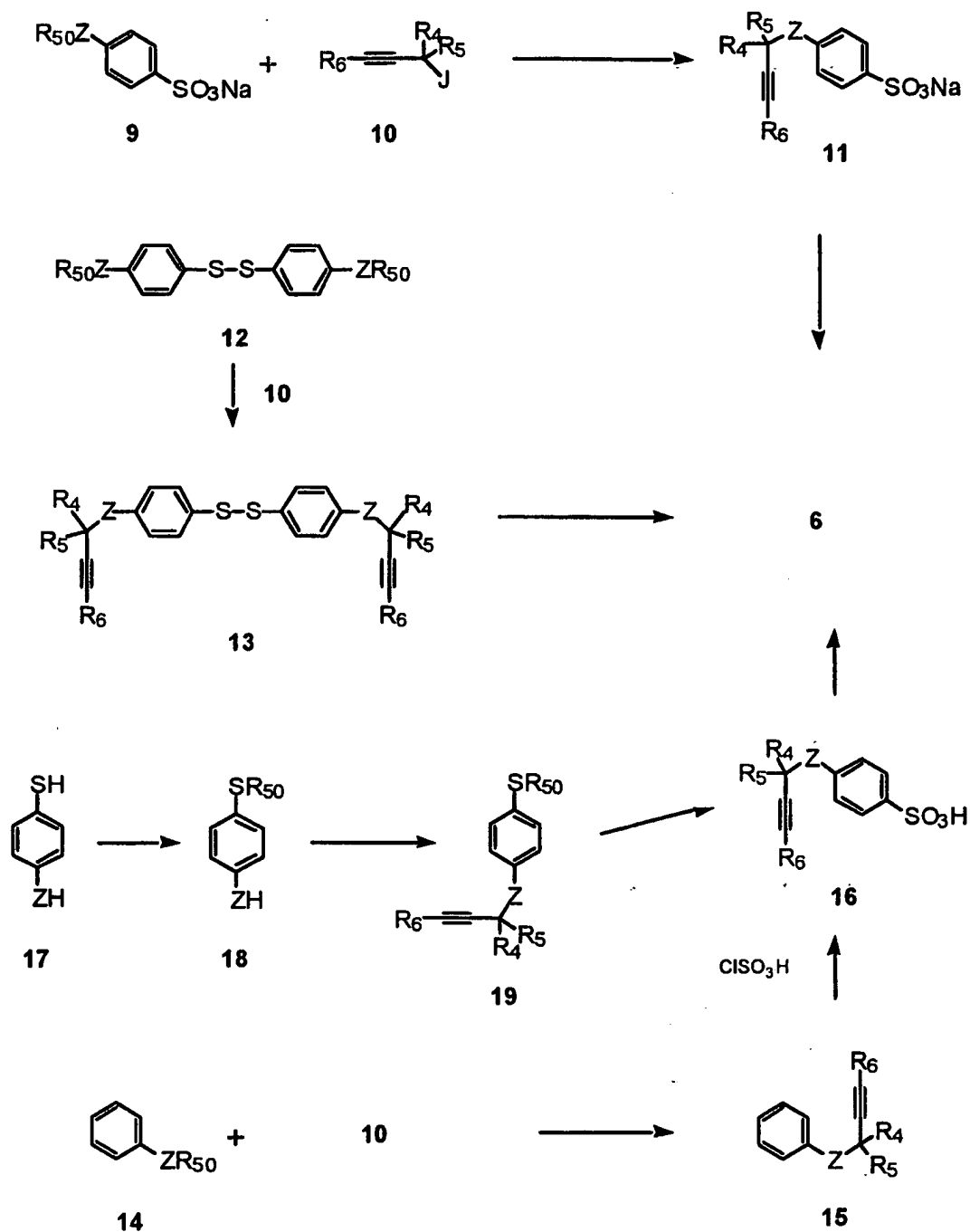
Scheme 2B:



Methods of preparation of sulfonylating agents **6** are shown in **Scheme 3**. Thus, sulfonic acid salts **9**, where ZR_{50} is a hydroxy, thiol or substituted amino moiety may be alkylated with acetylenes **10**, where J is a suitable leaving group such as halogen mesylate, tosylate, or triflate to give **11**. Acetylenes **10** are commercially available or known compounds, or they may be synthesized by known methods by those skilled in the art. The sulfonic acid salts **11** may be converted into the corresponding sulfonyl chloride or other sulfonylating agent **6** by known methods, such as reaction with oxalyl chloride or other reagent compatible with substituents R_4 , R_5 and R_6 and the alkyne. Alternatively, the disulfide **12** may be converted into diacetylene **13** by reaction with compounds **10**, followed by reduction of the disulfide bond to provide the analogous thiols which may be converted into **6** by known methods. Alkylation of the phenol, thiophenol, aniline or protected aniline **14** with **10** to give **15**, followed by reaction with chlorosulfonic acid provide sulfonic acids **16** which are readily converted into **6** with oxalyl chloride or similar reagents. Thiophenols **17** are also precursors to **6** via protection of the thiol, alkylation of ZH, where Z is O, N or S, and deprotection of the sulfur followed by oxidation to the sulfonic acid **16**.

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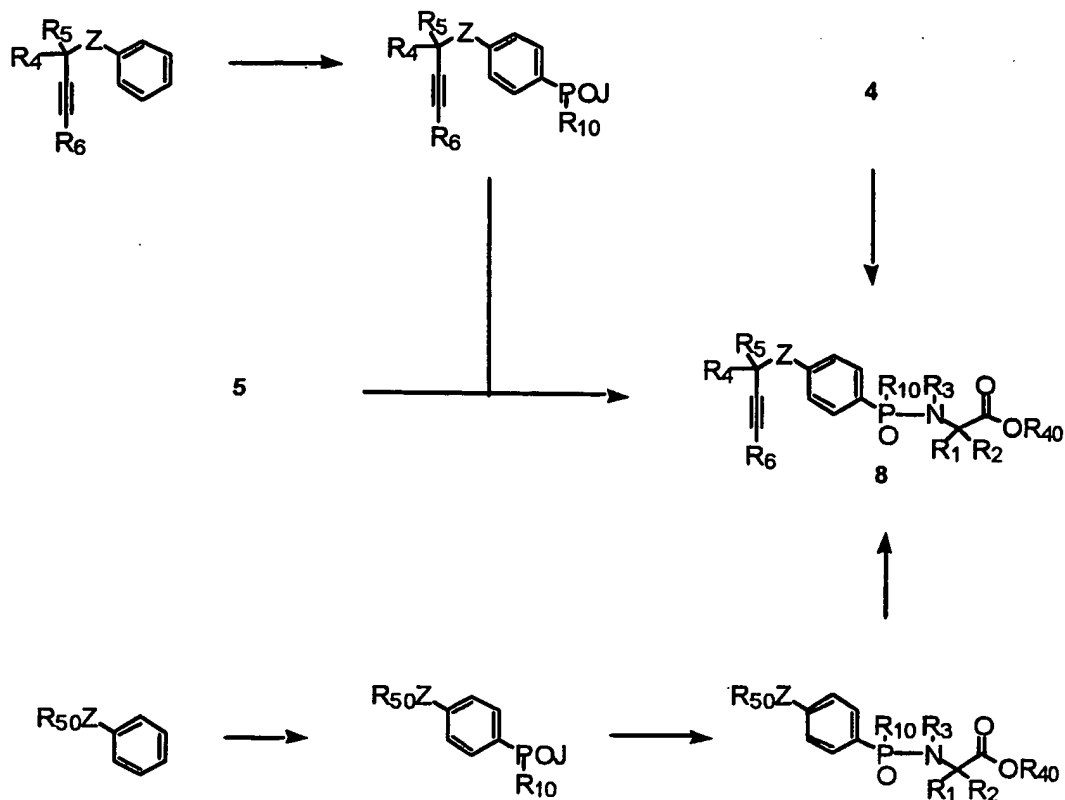
Scheme 3:



The phosphorus containing analogs of 8 may be prepared using similar methodology, as shown in Scheme 4.

-44-

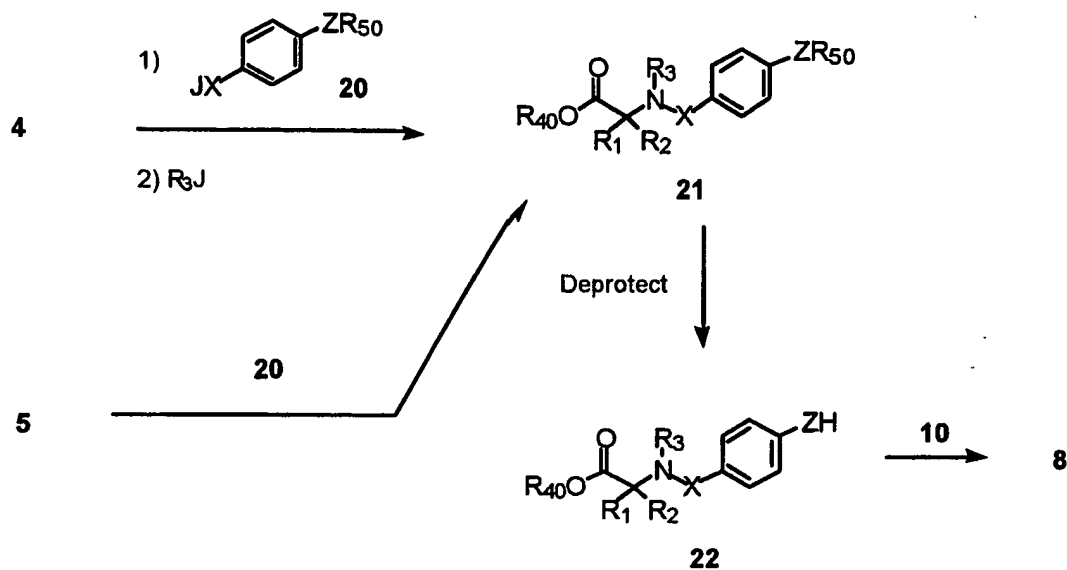
Scheme 4:



- The acetylenic side chain may also be appended after sulfonylation or phosphorylation of the amino acid derivative, as shown in **Scheme 5**. Thus, the amino acid derivatives 4 and 5 can be sulfonylated or phosphorylated with compounds 20, where ZR₅₀ is hydroxy or protected hydroxy, thiol or amine, and, if necessary, alkylated as in **Scheme 2**, to give 21. Removal of the R₅₀ masking group to give 22 and subsequent alkylation of the resulting phenol, thiol or amine with 10 provides 8.
- In the case where ZR₅₀ is equal to OH, no deprotection step is required to give 22.

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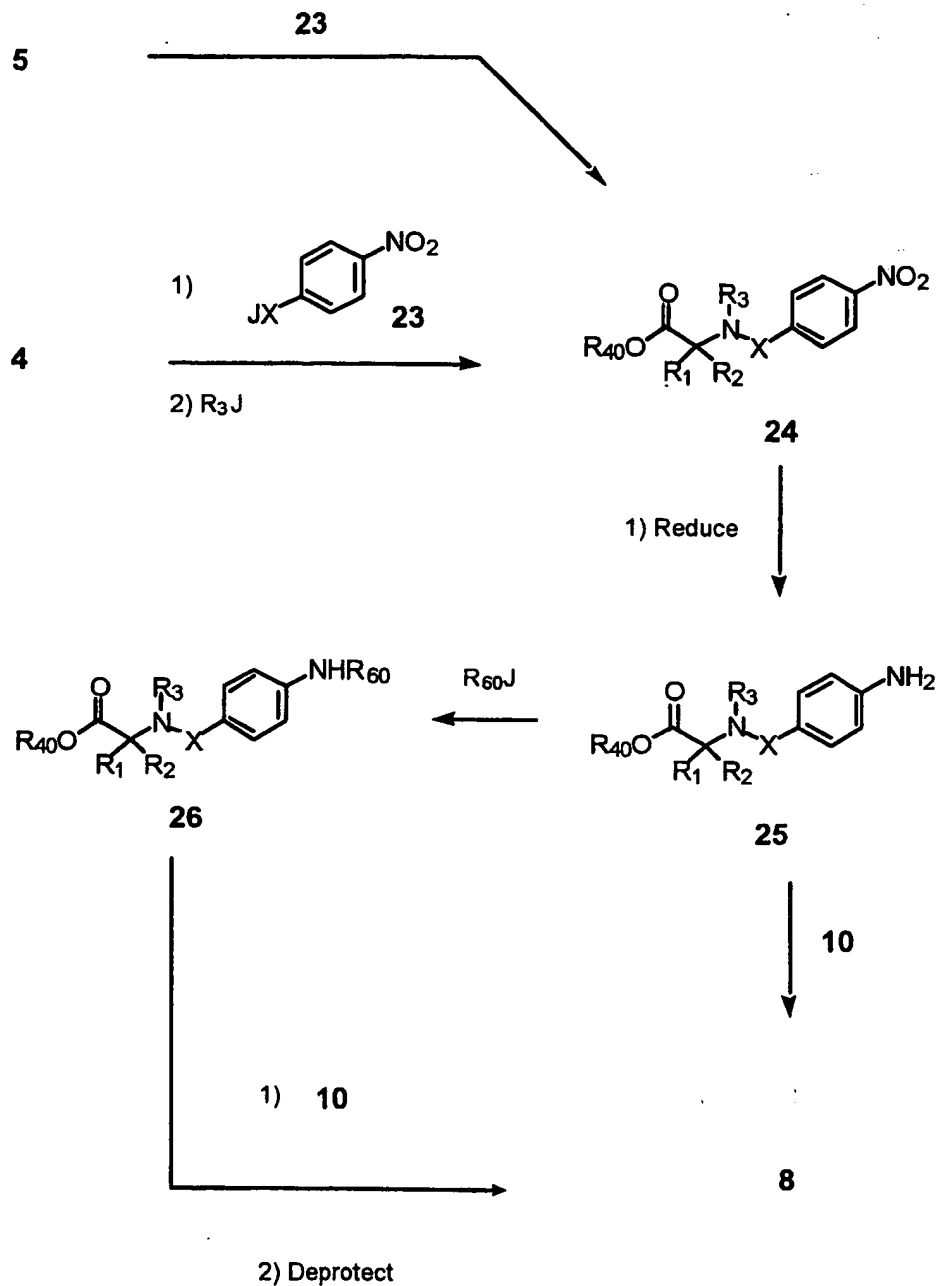
Scheme 5:



The propargylic amine analogs of 8 can be synthesized as shown in Scheme 6 starting from the amino acid derivatives 4 and/or 5. Sulfenylation or phosphorylation with para-nitro aryl compound 23, for example 4-nitrobenzenesulfonyl chloride, followed by alkylation with R₃J (for 5) using a base such as potassium carbonate or sodium hydride in DMF provides 24. Reduction of the nitro moiety with hydrogen and palladium on carbon, tin chloride or other known method to give aniline 25 and subsequent alkylation with 10 then provides 8. Aniline 25 may be derivatized (26) prior to alkylation with 10 and then deprotected after the alkylation step.

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Scheme 6:

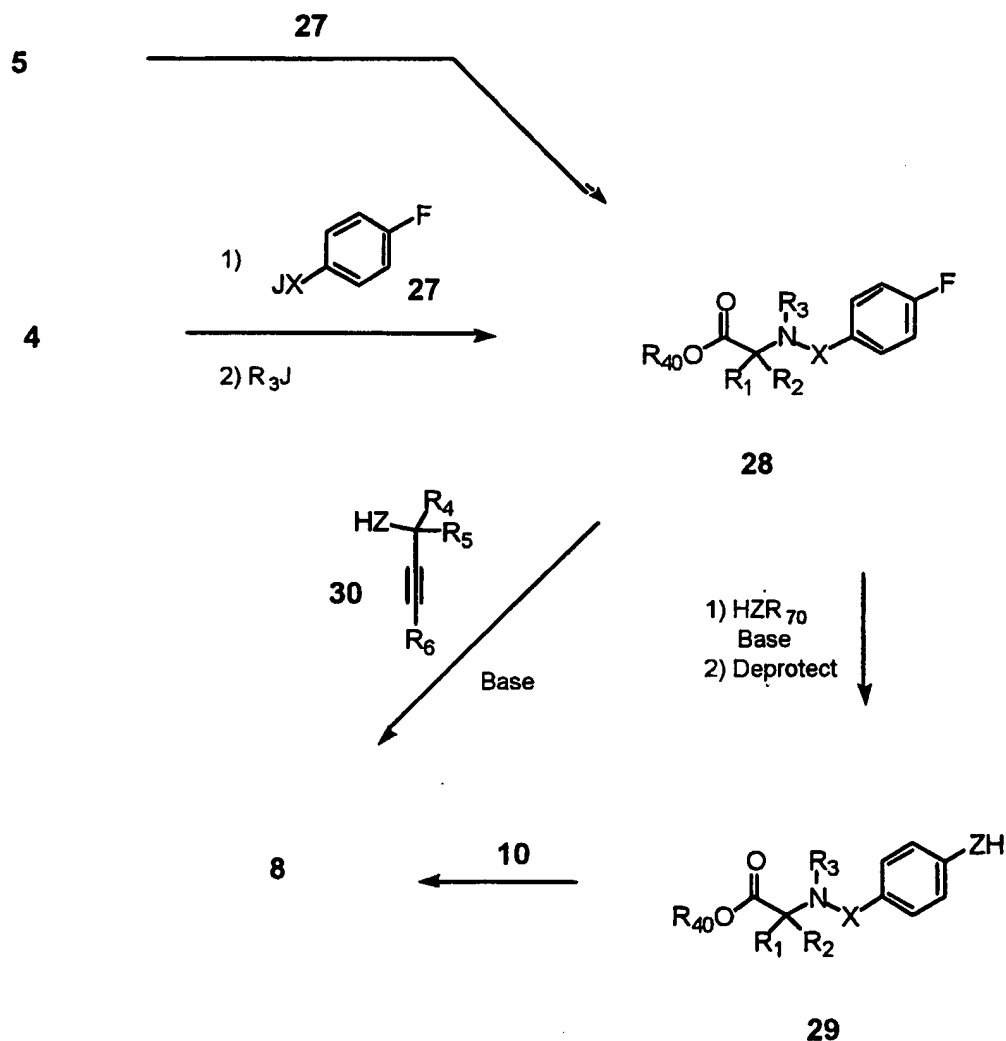


Acetylenic derivatives **8** are also accessible via the fluoro compounds **28**, readily prepared from the amino acid derivatives **4** and/or **5** by reaction with fluoroaryl **27**, as shown in Scheme 7. Displacement of the fluorine of **28** in the presence of a base such as sodium hydride with a masked hydroxy, thiol, or amino group (HZR_{70} , where R_{70} is a suitable protecting group) in a polar aprotic solvent such as DMF, followed by deprotection gives **29**, which can then be alkylated with **10** to

-47-

provide **8**. Conversion of **28** to **29**, where Z is sulfur, might also be accomplished with Na_2S , K_2S , NaSH or $\text{KS}(\text{C}=\text{S})\text{OEt}$. Disulfide obtained as a result of this displacement followed by oxidation can be reduced to the desired thiol using triphenylphosphine or a similar reducing agent. The fluorine of **28** can also be
 5 displaced in a polar aprotic solvent with the propargylic derivative **30**, where Z is O, S or NH, in the presence of a base such as sodium hydride, to give **8** directly.

Scheme 7:

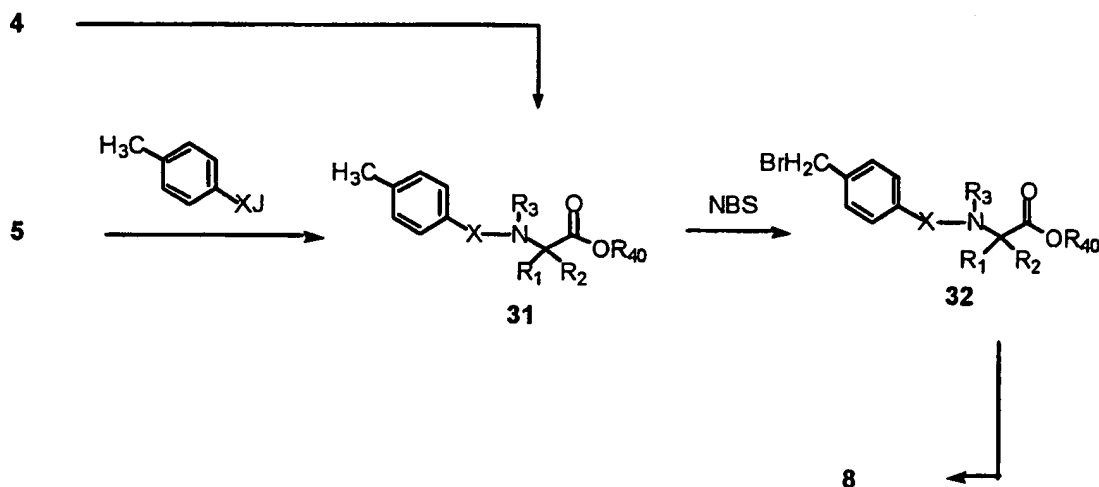


10 Compound **8**, wherein Z is a methylene group, is available via **31**, as shown in Scheme 8. Benzylic bromination of **31** with N-bromosuccinimide in a chlorinated

-48-

hydrocarbon solvent provides bromide **32**. This is followed by displacement of the bromide with the appropriate propynyl cuprate to provide sulfonamide **8**.

Scheme 8:

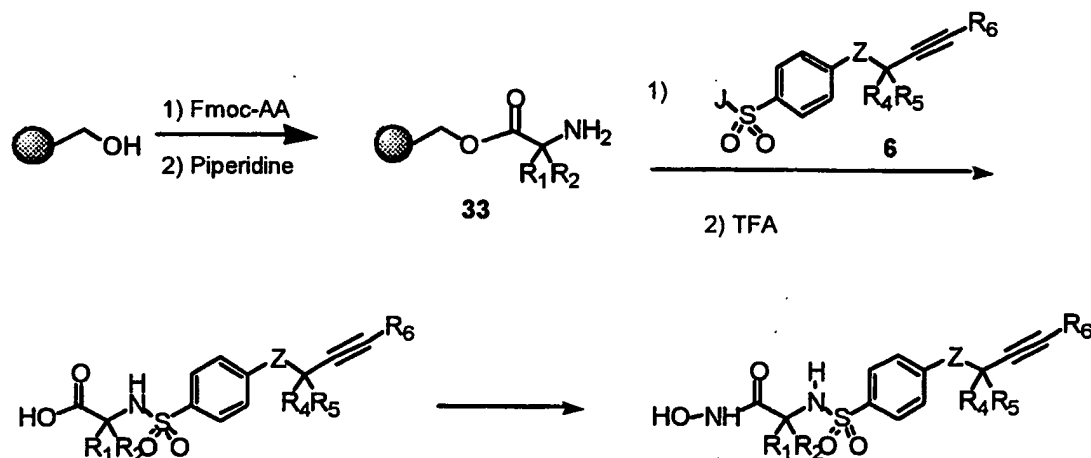


5

Methods for the solid phase synthesis of the compounds of the invention are shown in **Scheme 9** and **Scheme 10**. In **Scheme 9** an Fmoc protected amino acid, or any suitably N-protected amino acid, is bound to a resin using peptide coupling reagent such as 1,3-diisopropylcarbodiimide (DIC) and 1-hydroxybenzotriazole (HOBt) in a polar aprotic solvent such as DMF at room temperature. An amine such as piperidine in an inert solvent such as DMF at room temperature then removes the Fmoc masking moiety and the resulting free amine, **33**, can be sulfonylated with compound **6** in the presence of a tertiary amine base or pyridine. The carboxylic acid **2** ($R_3 = H$) is then released from the resin with TFA or other strong acid. The resulting carboxylic acids can be converted into the corresponding hydroxamic acids **1** ($R_3 = H$) as in **Scheme 1**.

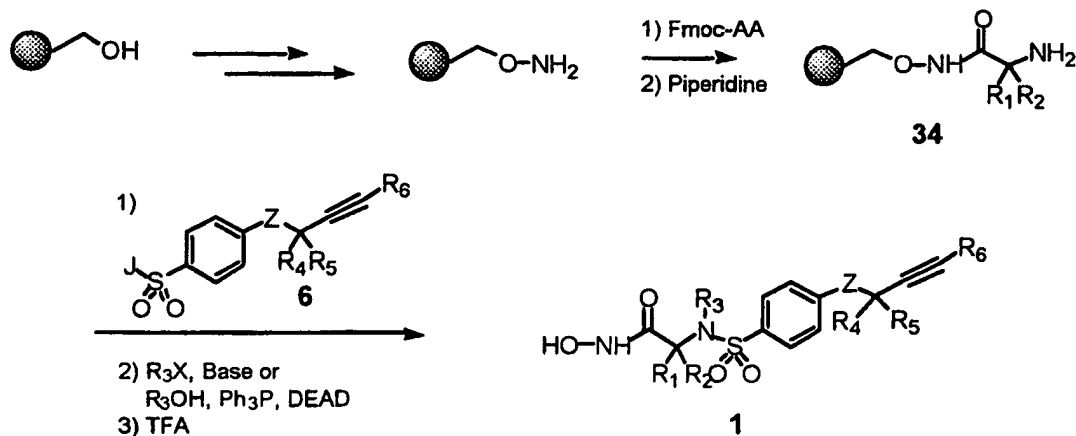
-49-

Scheme 9:



- In **Scheme 10** a hydroxylamine linked resin is constructed following known methods (Rickter, L. S.; Desai, M. C. *Tetrahedron Lett.* **1997**, 38, 321) and a suitably protected amino acid is bound to the resin and deprotected as in **Scheme 9** to give 34.
- Sulfonylation of the free amine may be followed by alkylation of the NH-sulfonamide with R₃J and a base, wherein J is a leaving group such as halide sulfonate or triflate, or via a Mitsunobu protocol. Cleavage of the hydroxamate from the resin is then accomplished using a strong acid such as trifluoroacetic acid to provide 1.
- Alternatively, the NH-sulfonamide is cleaved from the resin without alkylating to give the NH-sulfonamide hydroxamic acids (1, R₃ = H).

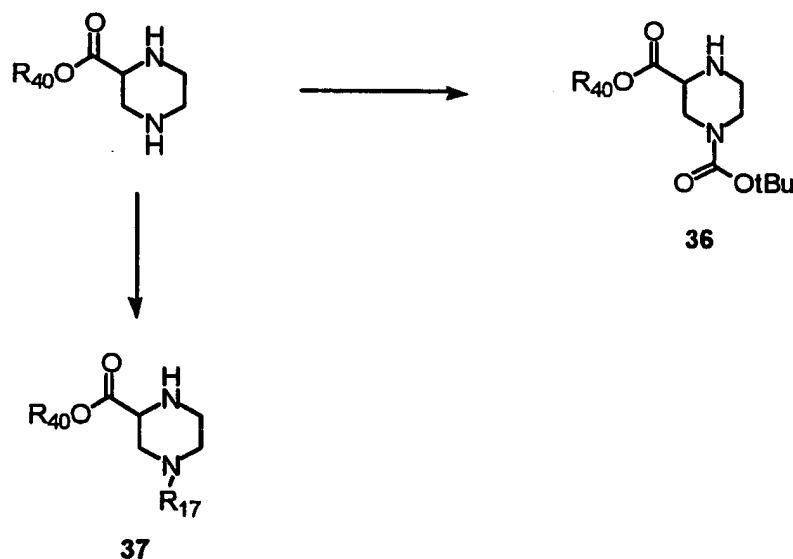
Scheme 10:



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In Scheme 11 commercially available piperazine-2-carboxylic acid (35) or its ester (Demaine, D. A.; Smith, S.; Barraclough, P. *Synthesis* 1992, 1065; Rissi, E.; Jucker, E. *Helv. Chim. Acta* 1962, 45, 2383.) may be functionalized predominantly at the N-4 position, as described in U. S. Patent 5,753,653 and in *Synthesis* 1992, 1065 and references cited therein, to give 36 or 37. Sulfonylation or phosphorylation at N-1 followed by the requisite functional group manipulations as described in Schemes 2-8, provides compounds of structure 2, wherein R₁ and R₃ together with the atoms to which they are attached form a piperazine ring. The t-butyl carbamate of compound 36 can be removed after sulfonylation or phosphorylation of N-1, followed by derivatization of N-4 with a variety of functional groups. Conversion to the hydroxamic acids is as shown in Scheme 1.

Scheme 11:



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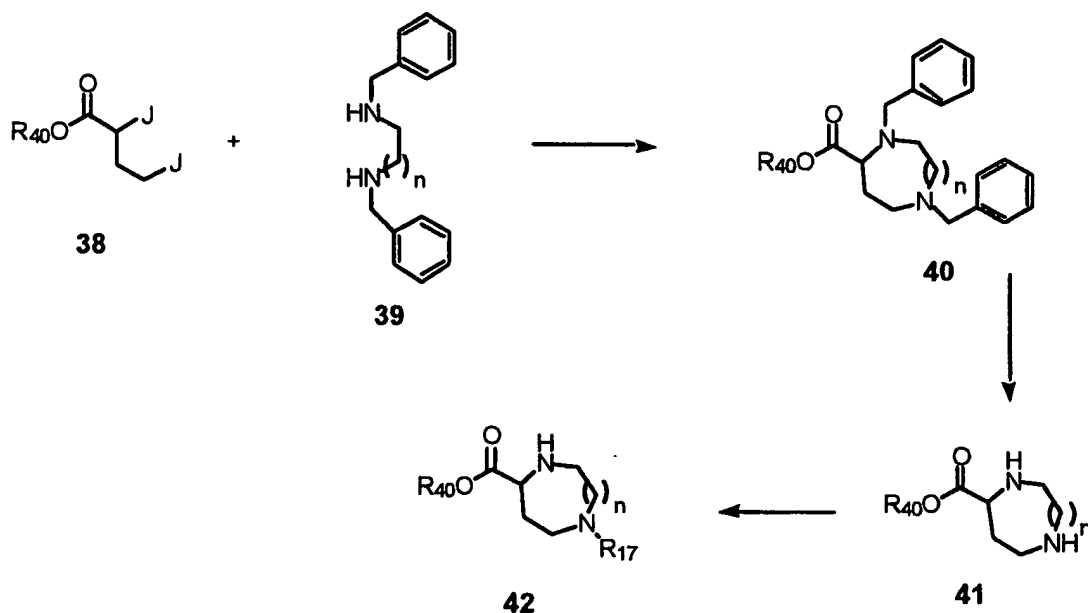
The preparation of intermediates for the synthesis of the diazepine or diazocine analogs of 1 is described in Scheme 12. An ester derivative 38 such as ethyl 1,4-dibromobutyrate, bearing two leaving groups, J, can react with a protected diamine 39, such as *N,N'*-dibenzylethylenediamine in the presence of a tertiary amine base in a non-polar solvent such as benzene, to provide the 7 or 8-membered ring 40. Deprotection of 40 using hydrogen and a palladium catalyst gives the cyclic diamine

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-51-

41. Functionalization of **41** predominantly at N-5 provides **42**. Compound **42** may then be sulfonylated followed by removal of R_{17} , if desired, and subsequent alkylation, acylation or sulfonylation of N-5. Conversion into compound **1** is then accomplished according to Schemes 1-8. Alternatively, N-5 alkyl compounds can be prepared by carrying through the N-5 t-butyl carbamate through to the hydroxamic acid stage, followed by removal of the carbamate and N-5 alkylation with an alkyl halide and tertiary amine base in the presence of the hydroxamic acid.

Scheme 12:



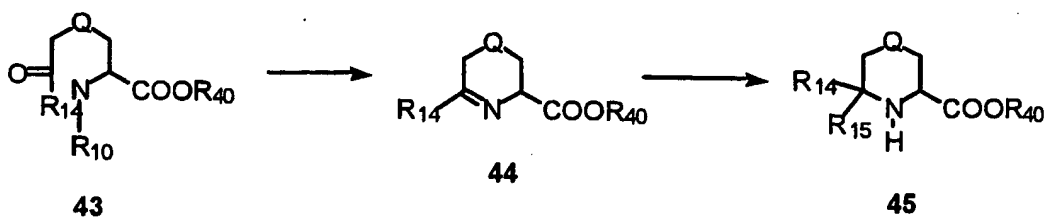
10

Piperidine, morpholine and piperazine derivatives of compound **1** are available according to Scheme 13. Amino-ketone **43**, wherein Q is O, S or NR₁₇, undergoes removal of protecting group R₁₀, wherein R₁₀ is a benzyl, t-butoxycarbonyl, benzyloxycarbonyl or other suitable masking group, followed by intramolecular reductive amination to give the cyclic imine **44**. Imine **44** reacts in ethereal solvents with a nucleophile, R₁₅M, in which M is lithium, magnesium halide or cerium halide to provide the saturated 6-membered ring **45**. A variety of protecting groups may be required for functionality in R₁₅, prior to metallation. Compounds **45** may then be converted into compounds of structure **1** according to Schemes 1-8.

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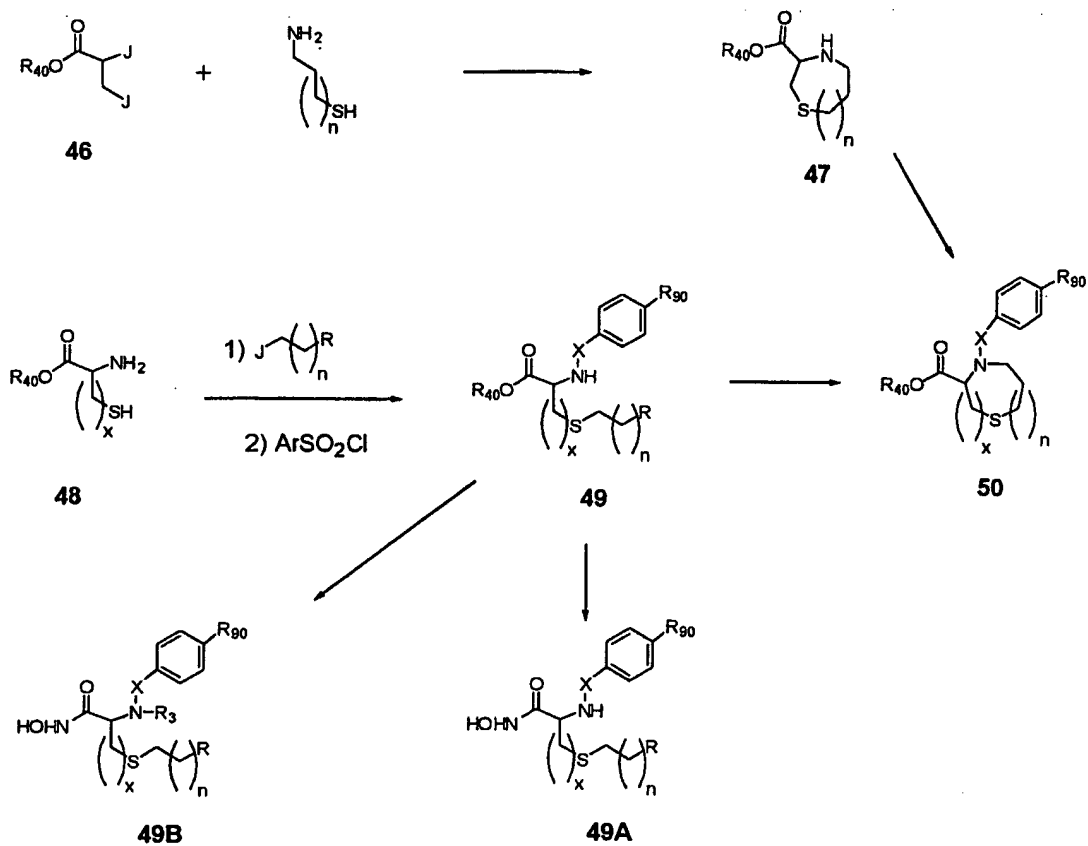
Scheme 13:



Thiomorpholines, thiazepines and thiazocines of the invention may be constructed according to Scheme 14. An ester **46** such as 1,3-dibromopropionate, containing two leaving groups, J, can react with an amino-thiol to provide thiazepine **47** which can then be converted into compounds of structure **1** according to Schemes 1-8. Alternatively, cysteine or homocysteine derivative **48**, in the amino acid or amino-ester form, can be alkylated with alkyl halides such as 2-bromoethanol or 3-bromo-1-propanol to give alcohol **49** ($\text{R}=\text{OH}$) after sulfonylation or phosphorylation of the free amine group. The moiety R_{90} of compound **49** is consistent with the methods disclosed in Schemes 2-8 for subsequent conversion into compounds **1** of the invention and includes nitro, fluoro, methoxy, hydroxy and $-\text{ZCR}_4\text{R}_5\text{CCR}_6$, where Z is O, NR_{17} , or S. Alcohol-sulfonamide **49** can be ring-closed using standard Mitsunobu conditions to afford thiomorpholine or thiazepine **50** which can be converted into compounds of structure **1** according to Schemes 1-8. The acyclic intermediate **49** can also be carried forward to the desired hydroxamic acids **49A** and **49B** via ester hydrolysis and hydroxamate formation, with or without prior alkylation of the sulfonamide nitrogen. The R moiety of compound **49** can be manipulated prior to conversion into **49B**. For example, when R is a hydroxyl group, conversion of the $-\text{OH}$ group into a leaving group followed by displacement with amines and subsequent ester hydrolysis and hydroxamate formation gives compounds **49B** where R is a secondary amine.

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Scheme 14:

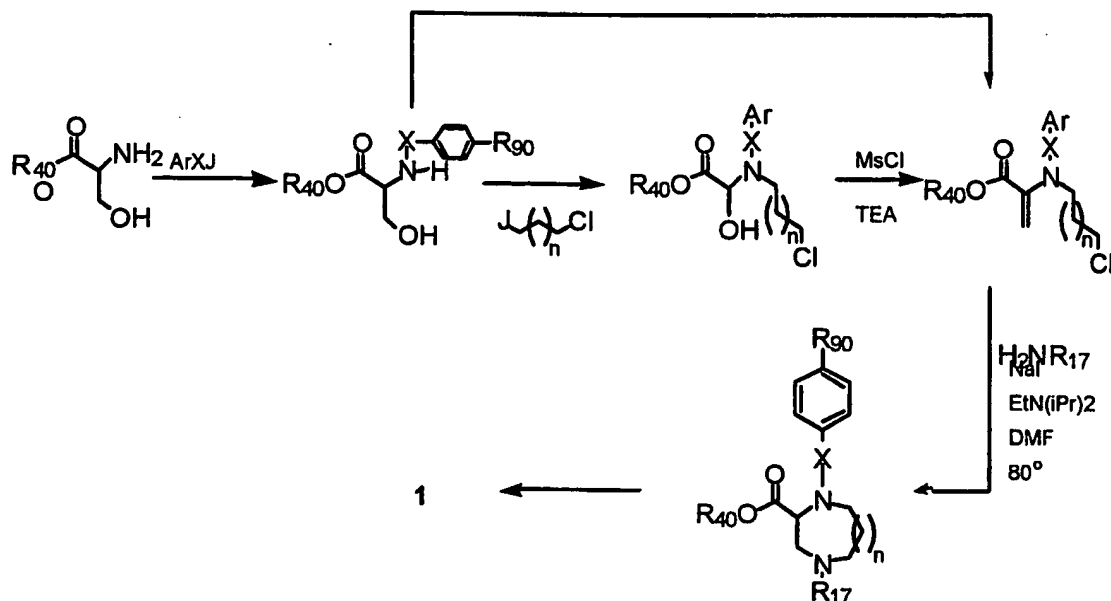


Diazepines or diazocines may be constructed according to **Scheme 15**, as described in *Bioorg. & Med. Chem. Lett.* **1998**, *8*, 2657, and modified according to

5 **Schemes 1-8** to provide diazepines of structure **1**.

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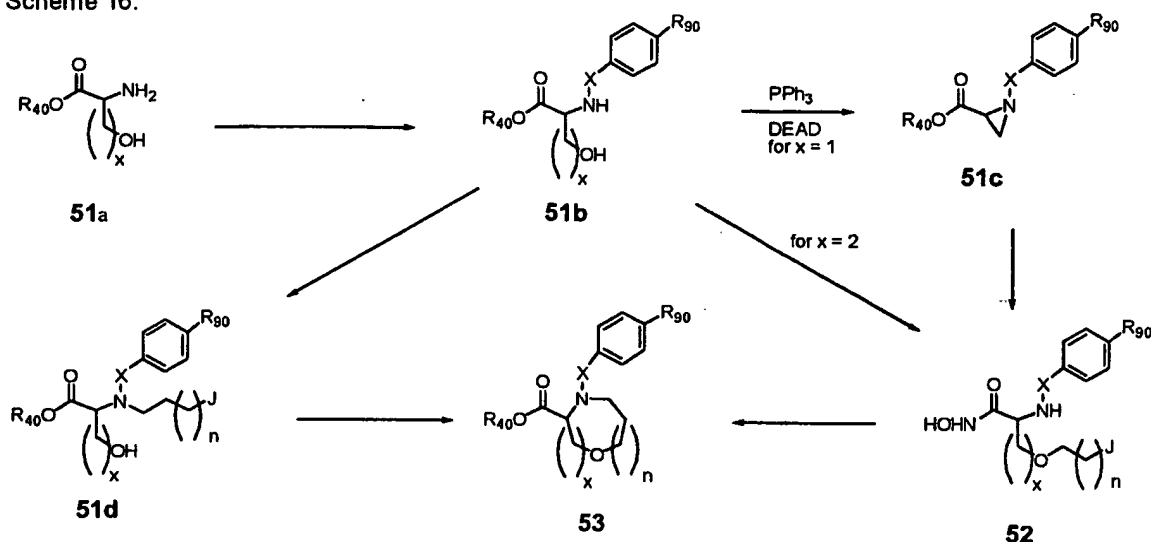
Scheme 15:



- Morpholines, oxazepines and oxazocines of the invention are prepared as shown in **Scheme 16**. A serine derivative, **51a** ($x = 1$), is sulfonlated or phosphorylated to give **51b** and then converted into the aziridine **51c**. Nucleophilic ring opening of the aziridine with a bifunctional alcohol species, such as 2-bromoethanol, 1,3-propanediol or 3-chloro-1-propanol, then provides **52** ($n = 0,1$) which is ring-closed via intramolecular alkylation or Mitsunobu reaction to form **53**. Compound **53** can be converted into compounds of structure **1** according to **Schemes 1-8**. The homoserine derivative **51a** ($x = 2$) can also be sulfonlated to give **51b**, followed by O-alkylation to give **52**, with protection of the sulfonamide-NH as required, and subsequent ring closure as before to give **53**. Alternatively, the homoserine derivative **51b** can be N-alkylated to provide **51d**, followed by intramolecular etherification to give **53**.

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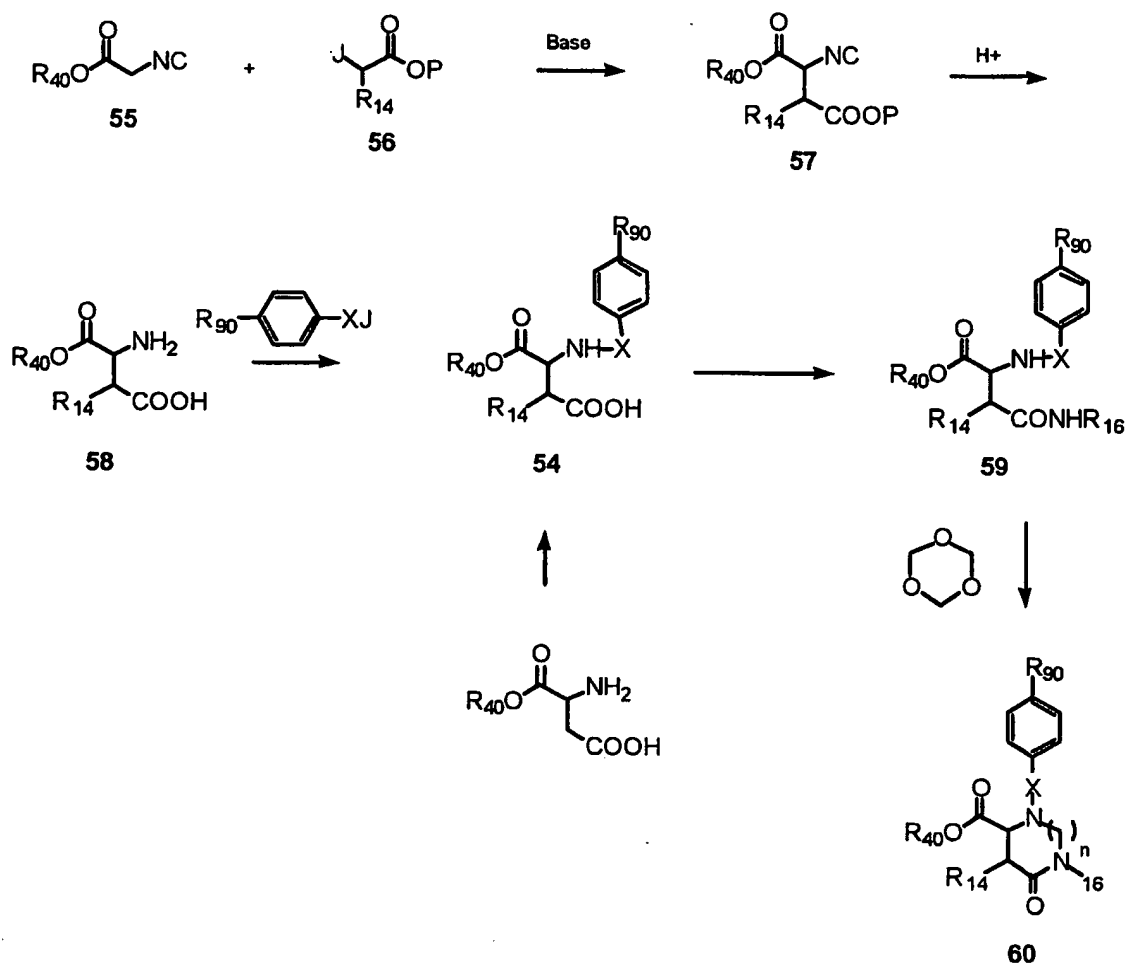
Scheme 16:



Methodology for preparing additional heterocyclic compounds of the invention are shown in **Schemes 17 and 18**. Aspartic acid derivatives may be accessed by direct sulfonylation or phosphorylation of aspartic acid to give **54**, followed by functional group manipulation as shown in **Scheme 17**. Alternatively, condensation of isonitrile **55** with alpha-halo ester **56** provides the diester which is selectively deprotected with concomitant conversion of the isonitrile into the amine, **58**. Sulfonylation or phosphorylation of **58** then provides **54**. Peptide coupling of a primary amine and compound **54** gives carboxamide **59** which can be cyclized using 1,3,5-trioxane to give heterocycle **60**. Seven and eight-membered ring analogs of **60** can be prepared by coupling the appropriate secondary amine, in which one of the amine substituents bears a n alcohol or leaving group, to carboxylic acid **54**. Intramolecular alkylation or Mitsunobu reaction then provides the cyclic structure. Compound **60** can be converted into compounds of structure **1** according to **Schemes 1-8**.

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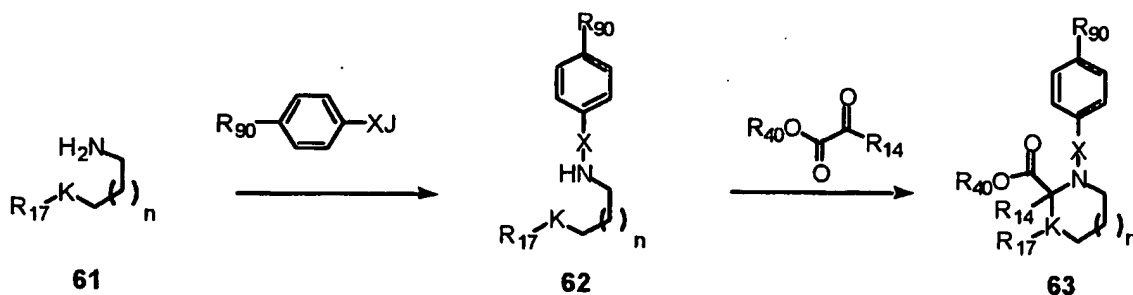
Scheme 17:



In **Scheme 18** the construction of compounds of the invention containing heterocyclic rings with a 1,3-orientation of the sulfonamide or phosphinic acid amide nitrogen and a heteroatom is described. Compound **61**, such as a diamine, an amino-
 5 alcohol or an amino-thiol, is sulfonylated or phosphorylated to give **62**. Addition of a pyruvate or glyoxylate group under standard conditions then forms the heterocycle **63**. Compound **63** can be converted into compounds of structure **1** according to **Schemes 1-8**.

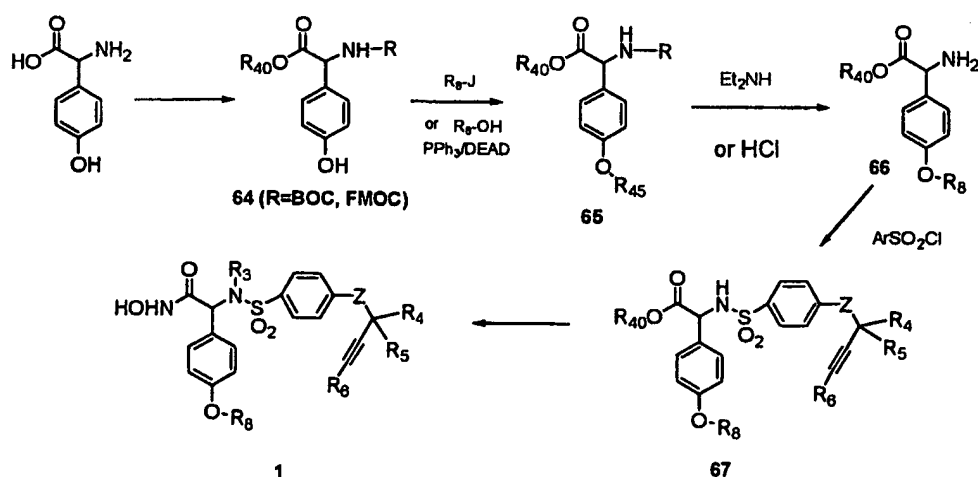
-57-

Scheme 18:



Compounds 1 of the invention derived from the amino acid D-4-hydroxyphenylglycine can be made as shown in **Scheme 19**. Esterification of the amino acid followed by protection of the amine as the t-butyl or fluorenylmethyl carbamate gives compound 64. Alkylation of the phenol via Mitsunobu reaction with the desired alcohol gives 65. Cleavage of the t-butyl or fluorenylmethyl carbamate using HCl or a secondary amine, respectively, then provides amino-ester 66. Compound 66 can then be sulfonlated to give NH-sulfonamide 67. At this point the NH-sulfonamide can be alkylated, or the amino acid side chain can be manipulated. Hydrolysis of the ester and subsequent conversion into the hydroxamic acid then provides compounds 1.

Scheme 19

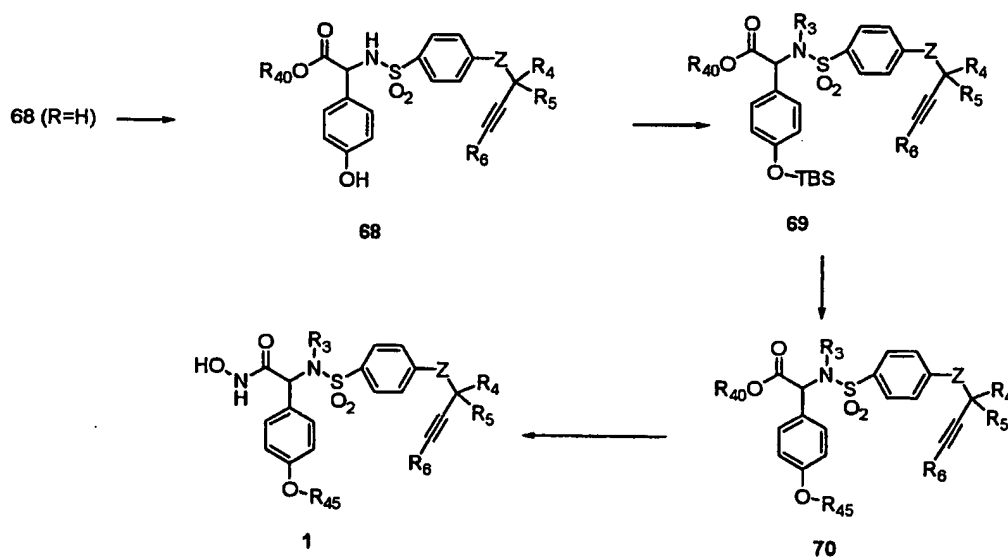


The N-alkyl sulfonamides derived from the amino acid D-4-hydroxyphenylglycine can be made as shown in **Scheme 20** via sulfonylation of the ester of D-4-hydroxyphenyl glycine to give 68. R₈ is as previously defined, or is a

-58-

protecting group known to those skilled in the art. Protection of the phenol with a trialkylsilyl, or other suitable protecting group, followed by N-alkylation with an alkyl halide in the presence of sodium hydride or potassium carbonate provides **69**. Removal of the silyl protecting group and functionalization of the unmasked phenol via Mitsunobu or base-catalyzed alkylation then provides **70**. Conversion of the ester into the desired hydroxamic acid then gives compounds **1** of the invention.

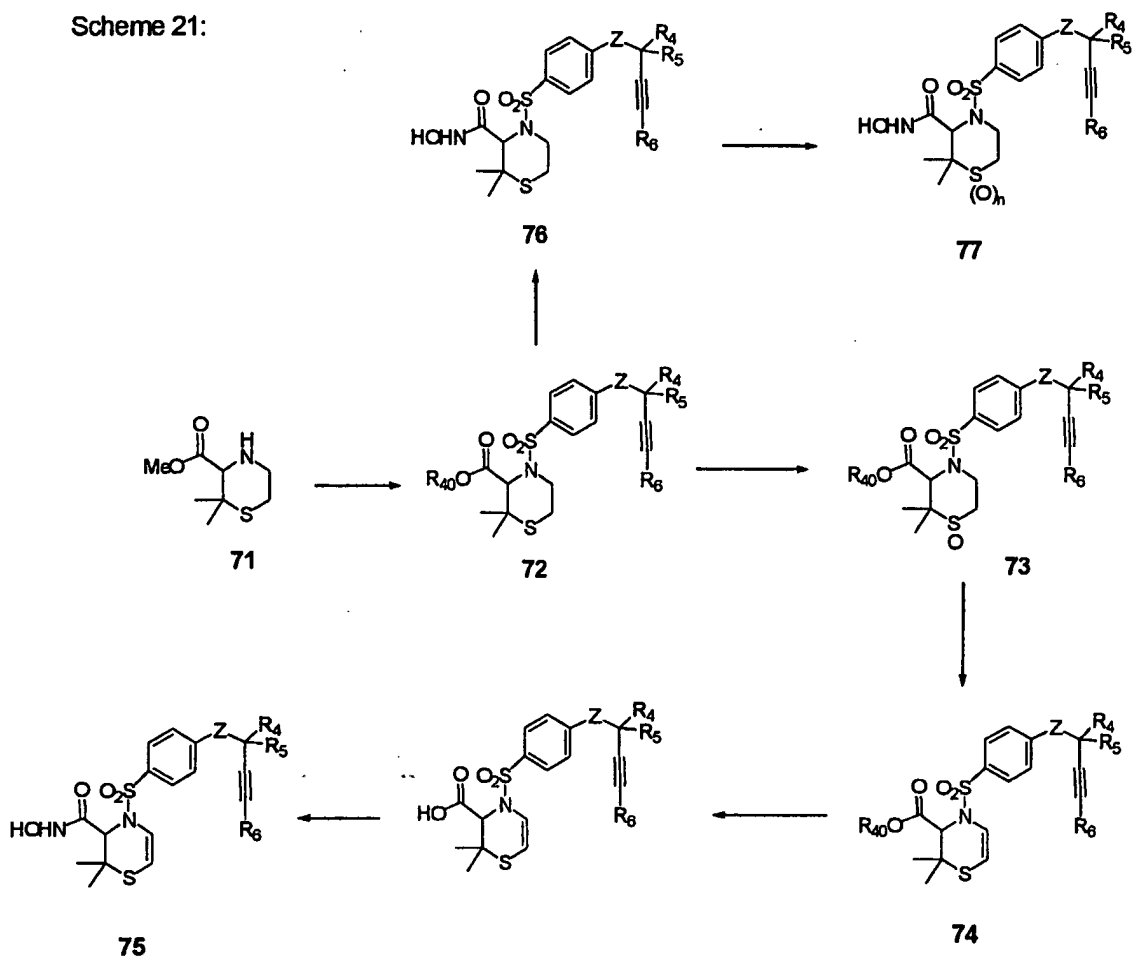
Scheme 20:



Compounds of the invention in which R₁ and R₃ together form a thiomorpholine ring can be made according to **Scheme 2**, in which the thiomorpholine ring is constructed prior to sulfonylation of the amine, or according to **Scheme 14**. The thiomorpholine ring may be manipulated after sulfonylation as shown in **Scheme 21** (Shown for the thiomorpholine derived from D-penicillamine). Thus, sulfonylation of the thiomorpholine **71**, gives **72**. Oxidation of the thioether with m-chloroperbenzoic acid or other suitable oxidizing agent gives a mixture of diastereomeric sulfoxides **73**. Pummerer rearrangement of the sulfoxides in acetic anhydride with subsequent elimination of the resulting acetate gives **74**. Ester hydrolysis of **74** followed by hydroxamate formation then gives **75**. Alternatively, **72** can be converted into the corresponding hydroxamic acid **76** which can be oxidized to the sulfoxide or sulfone with m-chloroperbenzoic acid or peracetic acid, respectively.

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Scheme 21:



Spiro-fused thiomorpholines are available as shown in **Scheme 22**. Reaction of

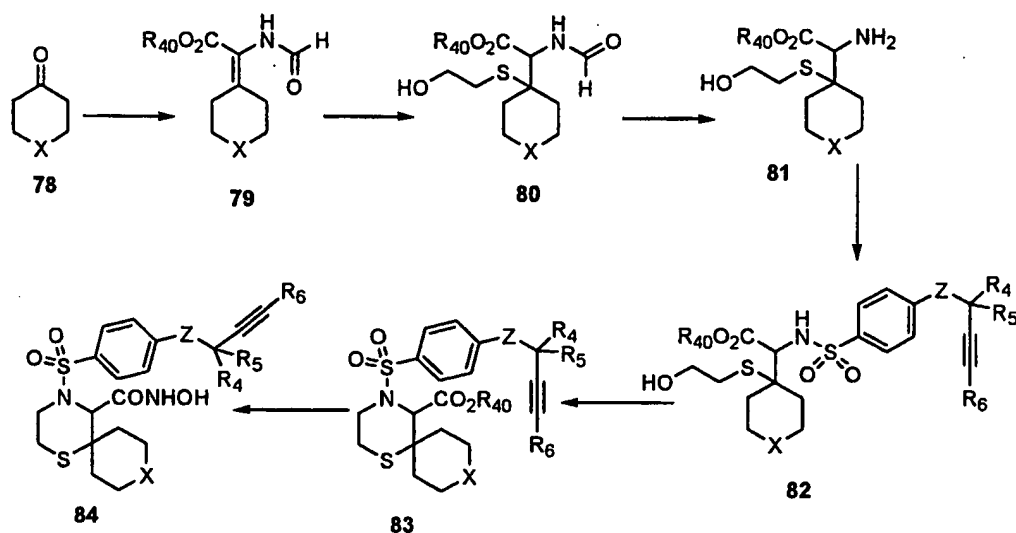
5 a cyclic ketone **78** ($X = S, SO, SO_2, NR$) with isocyanate **55** (**Scheme 17**) in the presence of a base such as sodium hydride gives formamide **79** after acid work-up. Use of an acyclic ketone in this reaction provides a route to other geminally disubstituted 2-

substituted thiomorpholines. Michael addition of 2-mercaptoethanol to **79** provides alcohol **80**. Hydrolysis of the formamide then gives amino-ester **81**. Sulfonation of **81**

10 gives hydroxy-sulfonamide **82** which can be cyclized to the thiomorpholine under Mitsunobu conditions to provide **83**. Ester hydrolysis and hydroxamate formation then gives **84**.

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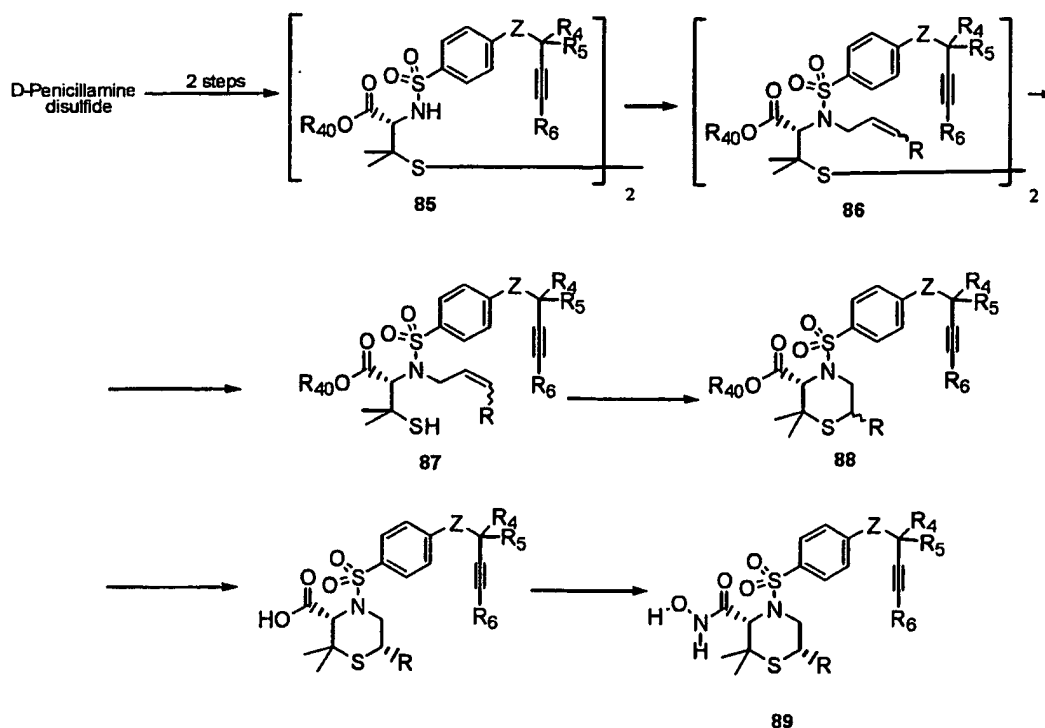
Scheme 22:



The preparation of 6-substituted thiomorpholines of the invention is shown, starting from D-penicillamine derivatives, in **Schemes 23-26**. Thus, in **Scheme 23** D-penicillamine disulfide or other S-protected penicillamine is esterified and sulfonylated to give **85**. Alkylation of the sulfonamide with an allylic bromide gives **86**. Deprotection of the thiol using tributylphosphine in the case of the disulfide gives the thiol-olefin **87** which can be cyclized in the presence of benzoyl proxide or other radical initiator to give a mixture of 6-methyl thiomorpholines **88**. Base hydrolysis followed by hydroxamate formation gives the cis-6-alkyl thiomorpholine **89**.

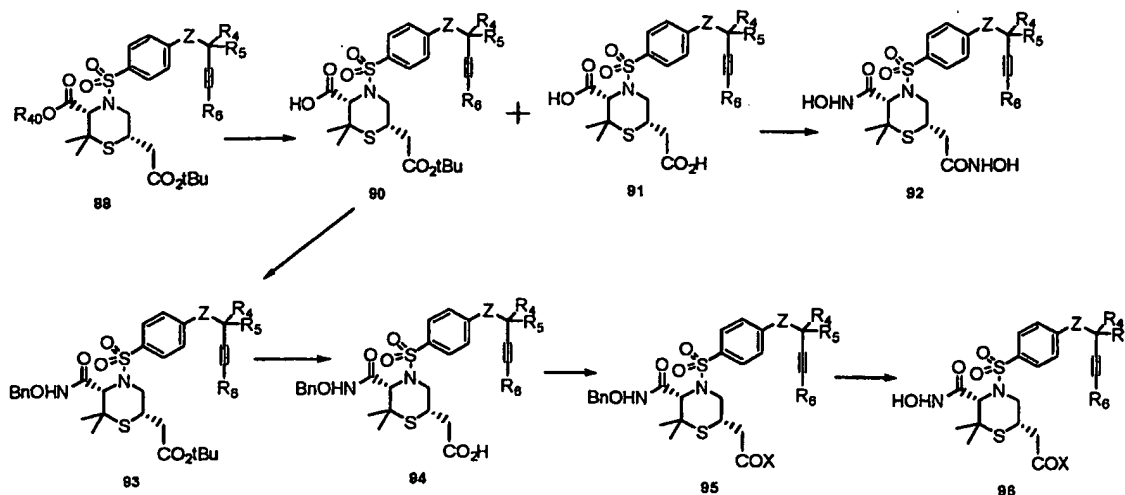
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Scheme 23:



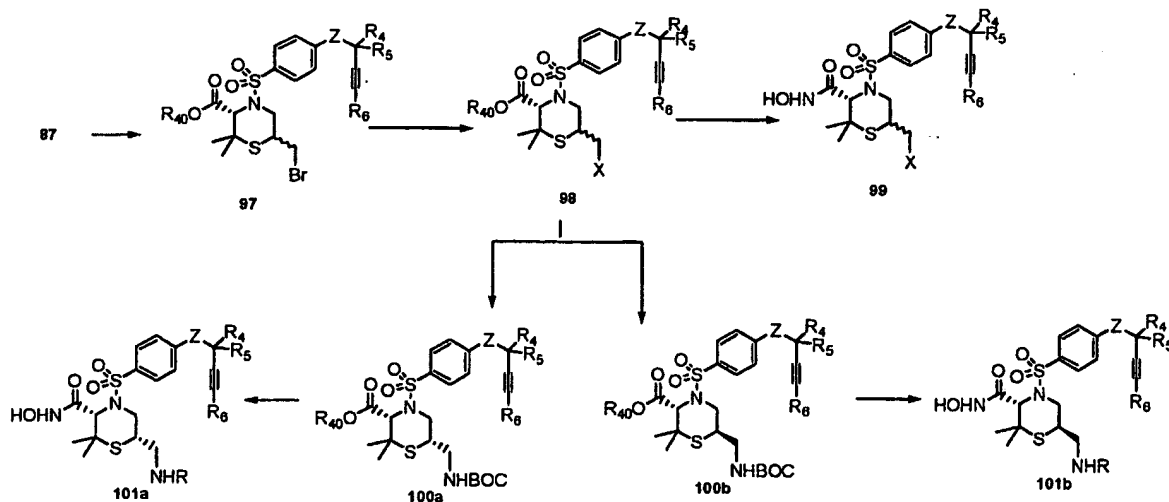
- In the case where R of compound 86 is a t-butyl ester deprotection of the thiol occurs with concomitant cyclization via an intramolecular Michael addition to give 88 as the major diastereomer (~10:1) with the 6-substituent cis to the 3-substituent. As shown in Scheme 24, lithium iodide ester cleavage of 88 provides a mixture of mono and diacids, 90 and 91. The diacid, 91, can be directly converted into the dihydroxamic acid 92. Monoacid 90 can be converted into the O-benzyl protected hydroxamic acid 93. Deprotection of the t-butyl ester with TFA or HCl then gives the acid 94.
- Derivatization of the acid with amines using standard peptide coupling reagents (EDC, HOBT, etc.) to form amides 95, followed by deprotection of the benzyl protecting group with boron tris(trifluoroacetate) and TFA provides compounds 96.
- Alternatively, the t-butyl ester of compound 88 can be selectively cleaved with TFA or HCl to give a monoacid. This acid can be converted into a variety of amides followed by cleavage of the C-3 ester and its conversion to the corresponding hydroxamic acid, compound 96.

Scheme 24:



In Scheme 25, compound 87 (R = H) is cyclized in the presence of bromine to give 97 as a mixture of diastereomers. The bromine of 97 may be displaced with a variety of nucleophiles to give 98, followed by ester hydrolysis and hydroxamate formation to give derivatives of structure 99. For the specific example wherein 97 is reacted with sodium azide in DMF to give a mixture of azides 98 (X = N₃), the azides can be reduced and carbamoylated to give a separable mixture of t-butyl carbamates, 100a and 100b. Ester cleavage with lithium iodide in ethyl acetate followed by hydroxamate formation gives either diastereomer 101a or 101b (R = BOC). Removal of the BOC protecting group at the hydroxamate stage provides either amine 101a or 101b (R = H). Alternatively, the BOC protecting group of 100 can be removed and the resulting amine acylated, alkylated or sulfonylated prior to hydroxamate formation. In this manner, compounds 101 bearing a variety of functional groups at R may be obtained.

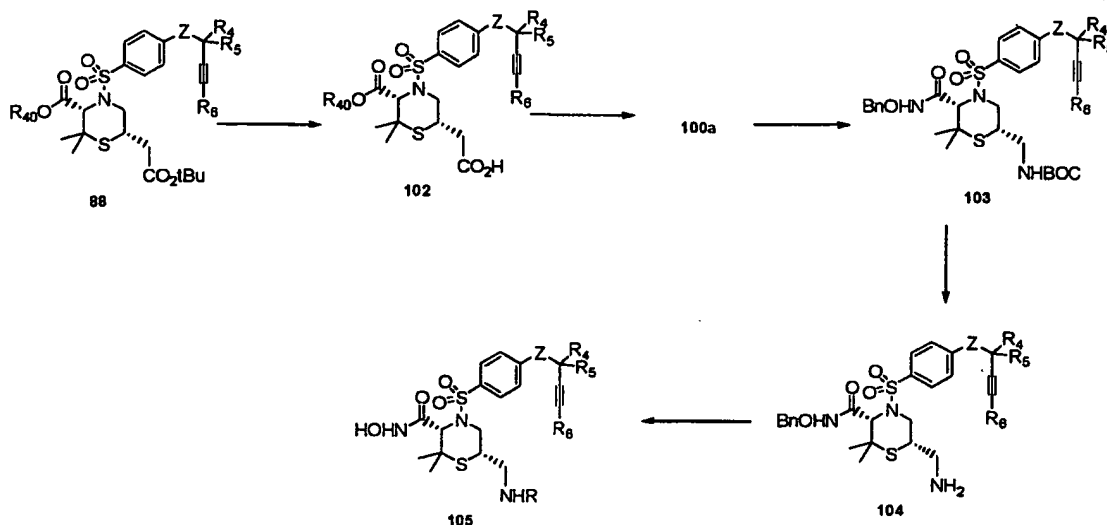
Scheme 25:



In Scheme 26 an alternative preparation of BOC-carbamate 100a is shown.

- 5 Thus, selective cleavage of the t-butyl ester of compound 88 with TFA or HCl provides the acid 102. Curtius rearrangement of this acid using diphenylphosphoryl azide triethylamine and t-butanol gives BOC-carbamate 100a as a single diastereomer. Cleavage of the C-3 ester of 100a with lithium iodide (for $R_{40} = \text{Me}$) followed by conversion of the resulting acid into the O-benzyl protected hydroxamic acid, using O-
- 10 benzylhydroxylamine and BOP-Cl gives 103. Deprotection of the t-butyl carbamate of 103 provides primary amine 104 which can be derivatized via alkylation, acylation or sulfonylation, followed by removal of the hydroxamate protecting group to provide analogs of structure 105.

Scheme 26:



Compounds of the invention can also be prepared by modifying substituents on the acetylenic side chain at any stage after sulfonylation or phosphorylation of the starting amino acid derivatives 4 or 5. Functional groups such as halogen, hydroxy, amino, aldehyde, ester, ketone, etc. may be manipulated by standard methods to form the moieties defined by R_1 , R_2 , R_3 and R_6 of compounds 1. It is recognized by those skilled in the art of organic synthesis that the successful use of these methods is dependent upon the compatibility of substituents on other parts of the molecule.

Protecting groups and/or changes in the order of steps described herein may be required.

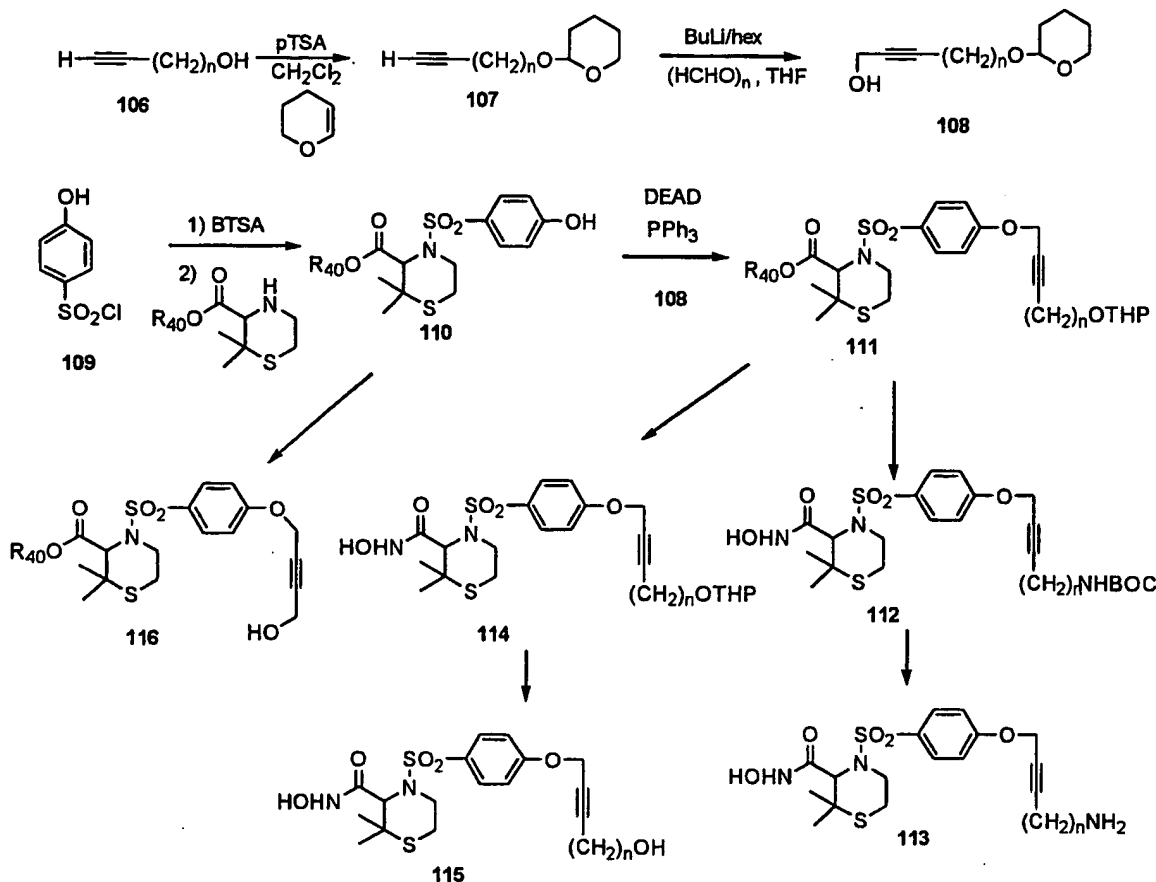
Scheme 27 describes some of the routes that may be used to append substituents onto the acetylenic side chain. Thus, selectively protected propargylic alcohols 108 are available from the known terminal alkynes 106 via reaction with dihydropyran or other suitable alcohol protecting group to give 107. Metallation of 107 with *n*-butyllithium and subsequent quenching of the anion with paraformaldehyde then gives 108. The phenolic coupling partner for alcohols 108 is made by silylating 4-hydroxybenzenesulfonyl chloride in situ with bis(trimethylsilyl)acetamide and then adding the thiomorpholine and a tertiary amine base. The resulting sulfonamide is desilylated in methanol to give 110. Alkylation of 110 with 108 using Mitsunobu

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conditions provides propargylic ethers 111. Removal of the THP protecting group of 111 with pyridinium para-toluenesulfonate in methanol gives the corresponding alcohol that is converted into a leaving group by sulfonylation or reaction with carbon tetrabromide and triphenylphosphine. Displacement of the leaving group with sodium azide followed by reduction and acylation, hydrolysis of the C-3 ester and hydroxamate formation gives 113. Alternatively, 111 can be hydrolyzed directly to the carboxylic acid and converted into hydroxamic acid 114. Removal of the THP protecting group at this stage then gives alcohol 115. The alcohol 115, where n is equal to 1, can be made by alkylating 110 directly with 2-butyne-1,4-diol using Mitsunobu conditions to provide 116. Compound 116 can then be converted into 113, where n is equal to 1, in the same manner as for alcohol 112. Compound 116 can be converted into hydroxamic acid 115 via acetylation of 116, followed by selective hydrolysis of the C-3 ester, hydroxamate formation and cleavage of the acetate with an aqueous base such as ammonium hydroxide. In a similar manner, ester derivatives of alcohols 115 and amide, sulfonamide and urea derivatives of 113 can be prepared.

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Scheme 27:

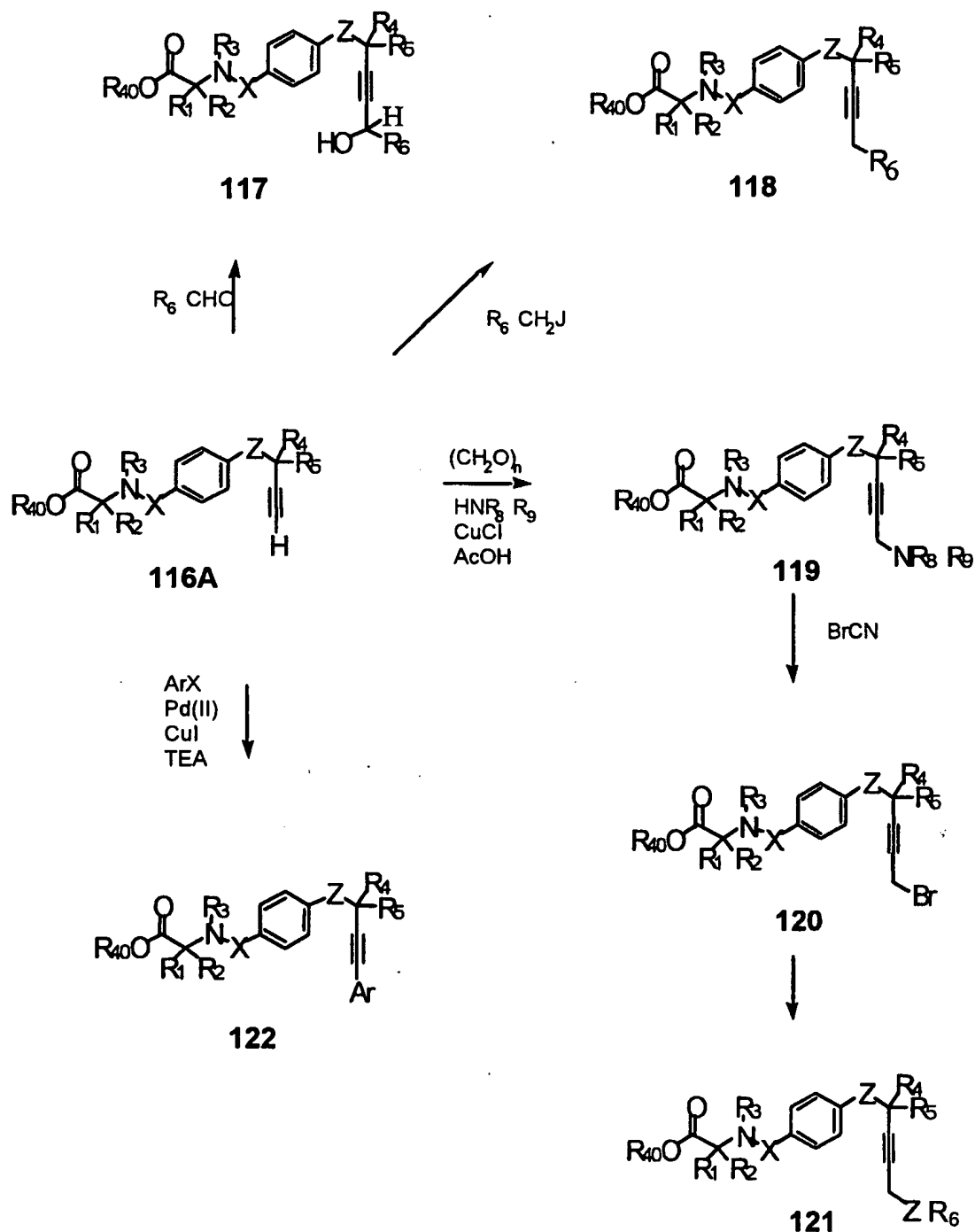


- Additional methods available for the derivatization of compounds of structure
- 5 **116A** (equivalent to compound **8** wherein R_6 is hydrogen) are shown in **Scheme 28**. Metallation of the terminal acetylene **116A** followed by addition of an aldehyde or alkyl halide, sulfonate or triflate provides derivatives **117** and **118**. Reaction of **116A** with formaldehyde and an amine provides the Mannich addition product **119**. Cyanogen bromide addition to **119** gives the propargylic bromide **120** which may be
- 10 displaced with a variety of nucleophiles to give, for example, ethers, thioethers and amines, **121**. Palladium catalyzed coupling reactions of **116A** provide the aryl or heteroaryl acetylenes **122**. It is recognized by those skilled in the art of organic synthesis that the successful use of these methods is dependent upon the compatibility of substituents on other parts of the molecule. Protecting groups and/or changes in the
- 15 order of steps described herein may be required. The variables are described

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previously. R_6 , R_7 and R_8 are as defined previously and may also include suitable protecting groups known to those skilled in the art.

Scheme 28:



The following specific examples illustrate the preparation of representative compounds of this invention. The starting materials, intermediates, and reagents are either commercially available or can be readily prepared following standard literature
5 procedures by one skilled in the art of organic synthesis.

Example 1

4-But-2-ynyloxy-benzenesulfonic acid sodium salt

To a solution of 52.35g (0.225 mol) of 4-hydroxybenzenesulfonate sodium
10 salt in 1L of isopropanol and 225 mL of a 1.0N solution of sodium hydroxide was added 59.96g (0.45 mol) of 1-bromo-2-butyne. The resulting mixture was heated to 70° for 15h and then the isopropanol was removed by evaporation in vacuo. The resulting white precipitate was collected by filtration, washed with isopropanol and ether and dried in vacuo to give 56.0g (100%) of the butynyl ether as a white solid.

15

Example 2

4-But-2-ynyloxy-benzenesulfonyl chloride

To a 0° solution of 43.8 mL (0.087 mol) of 2M oxalyl chloride/dichloro-
ethane solution in 29 mL of dichloromethane was dropwise added 6.77 mL (0.087
20 mol) of DMF followed by 7.24g (0.029 mol) of the product of **Example 1**. The reaction mixture was stirred for 10 minutes at 0° then let warm to room temperature and stirred for 2 days. The reaction was then poured into ice and extracted with 150 mL of hexanes. The organics were washed with water and brine, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 6.23g (88%) of the sulfonyl chloride as
25 a yellow solid; m.p. 63-65°C. EI Mass Spec: 243.9 (M⁺).

Example 3

But-2-ynyloxy-benzene

To a solution of 6.14g (0.023 mol) of triphenylphosphine dissolved in 100 mL
30 of benzene and 40 mL of THF was added 1.75 mL (0.023 mol) of 2-butyne-1-ol. After five minutes 2.00 (0.023 mol) phenol, dissolved in 10 mL of THF, was added to the

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reaction followed by 3.69 mL (0.023 mol) of diethyl azodicarboxylate. The resulting reaction mixture was stirred for 18h at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide 2.18g (70%) of the butynyl ether as a clear liquid.

5 EI Mass Spec: 146.0 MH+

Example 4

4-But-2-ynyloxy-benzenesulfonyl chloride

To a solution of 0.146g (1.0 mmol) of the product of **Example 3** in 0.3 mL
10 of dichloromethane in an acetone/ice bath under N₂ was dropwise added a solution of 0.073 mL (1.1 mmol) of chlorosulfonic acid in 0.3 mL of dichloromethane. After the addition was complete, the ice bath was removed and the reaction was stirred at room temperature for 2h. To the reaction was then dropwise added 0.113 mL (1.3 mmol) of oxalyl chloride, followed by 0.015 mL DMF. The reaction was heated to reflux for
15 2h and then diluted with hexane and poured into ice water. The organic layer was washed with brine, dried over sodium sulfate, and concentrated in vacuo to provide 0.130mg (53%) of the desired product as a light brown solid.

Example 5

20 2-[(4-Methoxy-benzenesulfonyl)-methyl-amino]-3-methyl- butyric acid tert-butyl ester

To a solution of 1.00g (2.915 mmol) of N-[(4-methoxyphenyl)sulfonyl]-D-valine *tert*-butyl ester (*J. Med. Chem.* **1997**, *40*, 2525) in 10 mL of DMF was added 0.128g (3.207 mmol) of 60% sodium hydride. After 30 minutes at room temperature
25 0.45 mL (7.289 mmol) of iodomethane was added and the reaction was stirred for 15h. The reaction mixture was then diluted with ether and washed with water. The organic layer was dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide 0.993g (95%) of the N-methyl sulfonamide as a colorless oil. Electrospray
30 Mass Spec: 357.9 (M+H)+

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Example 6**(2R)-2-[(4-Hydroxy-benzenesulfonyl)-methyl-amino]-3-methyl-butyrlic acid**

To a 0° solution of 0.707g (1.980 mmol) of the product of **Example 5** in 50 mL of dichloromethane was added 9.4 mL (9.395 mmol) of a 1.0M solution of boron tribromide in dichloromethane. The resulting mixture was stirred at 0° for 0.5h and then warmed to room temperature and stirred for an additional 4h. The reaction mixture was then poured into a saturated sodium bicarbonate solution and extracted with dichloromethane. The aqueous layer was acidified with 5% HCl solution and extracted with dichloromethane. The combined organics were dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to provide 0.271g (48%) of the phenol-carboxylic acid as a colorless oil. Electrospray Mass Spec: 287.9 (M+H)+

15

Example 7**(2R)-2-[(4-Hydroxy-benzenesulfonyl)-methyl-amino]-3-methyl-butyrlic acid methyl ester**

To a solution of 0.240g (0.836 mmol) of the product of **Example 6** in 5.0 mL of DMF was added 0.211g (2.509 mmol) of sodium bicarbonate followed by 0.104 mL (1.672 mmol) of iodomethane. The resulting mixture was stirred at room temperature for 4h and then diluted with water and extracted with ether. The combined organics were washed with saturated sodium bicarbonate solution, dried over MgSO₄, filtered and concentrated in vacuo to provide 0.210g (83%) of the methyl ester as a colorless oil. Electrospray Mass Spec: 300.3 (M-H)-

25

Example 8**2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-3-methyl-butyrlic acid**

To a solution of 0.187g (0.714 mmol) of triphenylphosphine in 3 mL of benzene was added 0.053 mL (0.714 mmol) of neat 2-butyne-1-ol followed by a solution of 0.172g (0.571 mmol) of the product of **Example 7** dissolved in 1.0 mL of

30

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THF. To the resulting reaction mixture was added 0.112 mL (0.714 mmol) of diethyl azodicarboxylate and the reaction was stirred for 15h at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide 0.159g (79%) of the butynyl ether-methyl ester.

To a solution of 0.159g (0.450 mmol) of the butynyl ether-methyl ester dissolved in 6.0 mL of methanol/THF (1:1) was added 0.5 mL of a 5.0N solution of sodium hydroxide. The resulting mixture was stirred at room temperature overnight and then acidified with 10% HCl solution and extracted with dichloromethane. The combined organics were dried over MgSO₄, filtered and concentrated in vacuo to provide 0.138g (90%) of the carboxylic acid as a white solid. Electrospray Mass Spec: 338.0 (M-H)-

Example 9

2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-butyramide

To a 0° solution of 0.48 mL (0.965 mmol) of a 2.0M solution of oxalyl chloride in dichloromethane, diluted with 4.1 mL of dichloromethane, is added 0.075 mL (0.965 mmol) of DMF and the reaction is stirred for 15 minutes at 0°. A solution of 0.109g (0.322 mmol) of the carboxylic acid product of **Example 8**, dissolved in 1 mL of DMF, was added to the reaction and the resulting mixture is stirred for 1h at room temperature and then poured into a 0° mixture of 1.0 mL of water, 4 mL of THF and 1.0 mL of a 50% aqueous solution of hydroxylamine. The reaction is allowed to warm to room temperature overnight and the organics are then concentrated in vacuo. The residue is diluted with ethyl acetate, washed with 5% HCl solution, water and saturated sodium bicarbonate, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.102g (89%) of the hydroxamic acid as a white solid. Electrospray Mass Spec 354.9 (M+H)+

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Example 10**2-[(4-Fluoro-benzenesulfonyl)-methyl-amino]-3-methyl-butyrlic acid methyl ester**

To a solution of 6.00g (0.051 mol) of D, L-valine in 380 mL of THF/water
5 (1:1) was added 10.9 mL (0.077 mol) of triethylamine followed by 9.94g (0.051 mol)
of 4-fluorobenzenesulfonyl chloride and the resulting mixture was stirred for 15h at
room temperature. The THF was then removed in vacuo and the resulting solution
was extracted with ethyl acetate. The combined organics were washed with 10% HCl
solution and water, dried over MgSO₄, filtered and concentrated in vacuo to provide
10 4.8g of the sulfonamide as a white solid.

To a solution of 4.8g (0.017 mol) of the sulfonamide in 30 mL of DMF was
added 14.5g (0.105 mol) of potassium carbonate followed by 4.35 mL (0.070 mol) of
iodomethane. The reaction was stirred at room temperature for 5h and then diluted
with water and extracted with ether. The combined organics were washed water,
15 dried over MgSO₄, filtered and concentrated in vacuo. The residue was
chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide
2.8g (53%) of the methyl ester as a colorless oil. Electrospray Mass Spec 303.9
(M+H)+

20

Example 11**2-[(4-Fluoro-benzenesulfonyl)-methyl-amino]-3-methyl-butyrlic acid**

To a solution of 2.7g (8.910 mmol) of the product of **Example 10** in 90 mL of
THF/methanol (1:1) was added 45 mL of a 1.0N sodium hydroxide solution and the
reaction was stirred at room temperature for 24h. The reaction mixture was then
25 acidified with 10% HCl solution and extracted with ethyl acetate. The combined
organics were dried over MgSO₄, filtered and concentrated in vacuo to provide 2.5g
(97%) of the carboxylic acid as a white waxy solid. Electrospray Mass Spec 287.9
(M-H)-

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Example 12**2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-
3-methyl-butyric acid**

To a solution of 3.17 mL (0.042 mol) of 2-butyne-1-ol in 60 mL of DMF at
5 room temperature was added 1.70g (0.040 mol) 60% sodium hydride. The resulting
mixture was stirred for 0.5h and then a solution of 2.45g (8.478 mmol) the product of
Example 11 dissolved in 20 mL of DMF was added to the reaction. The reaction
mixture was then heated to reflux for 24h, cooled to room temperature and then
acidified to pH 2 with 10% HCl solution. After stirring for 1h the resulting mixture
10 was diluted with water and extracted with ethyl acetate. The combined organics were
then dried over MgSO₄, filtered and concentrated in vacuo. The residue was
chromatographed on silica gel eluting with ethyl acetate/hexanes (1:2) to provide
1.67g (58%) of the desired carboxylic acid product as a white solid identical to the
product of **Example 8**.

15

Example 13**(4-Fluoro-benzenesulfonylamino)-acetic acid ethyl ester**

To a solution of 4.00g (0.029 mol) of glycine ethyl ester hydrochloride in 40 mL of
chloroform and 7.0 mL of pyridine was added 5.58g (0.029 mol) of 4-
20 fluorobenzenesulfonyl chloride and the reaction was stirred at room temperature for
15h. The reaction mixture was then washed with water and 5% HCl solution and the
organics were dried over MgSO₄, filtered and concentrated in vacuo. The resulting
white solid was washed with ether/hexanes (1:1) and dried in vacuo to provide 4.72g
(63%) of the sulfonamide as a white solid. Electrospray Mass Spec 261.8 (M+H)+

25

Example 14**[(4-Fluoro-benzenesulfonyl)-methyl-amino]-acetic acid ethyl ester**

To a solution of 3.00g (0.011 mol) of the product of **Example 13** in 30 mL of
DMF was added 4.76g (0.034 mol) of potassium carbonate followed by 1.43 mL
30 (0.023 mol) of iodomethane. The reaction was stirred at room temperature for 5h and
then diluted with water and extracted with ether. The combined organics were washed

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water, dried over MgSO_4 , filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide 3.0g (95%) of the N-methyl sulfonamide as a colorless oil. Electrospray Mass Spec 275.9 (M+H)+

5

Example 15

[(4-Fluoro-benzenesulfonyl)-methyl-amino]-acetic acid

According to the procedure of **Example 11**, 3.0g (0.011 mol) of the product of **Example 14** provided 2.32g (86%) of the carboxylic acid as a white solid.

10 Electrospray Mass Spec 245.9 (M-H)-

Example 16

[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-acetic acid

According to the procedure of **Example 12**, 0.350g (1.417 mmol) of the product of **Example 15** provided 0.164g (39%) of the butynyl ether-carboxylic acid as a white solid. Electrospray Mass Spec 297.9 (M+H)+

15

Example 17

2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-

20

N-hydroxy-acetamide

According to the procedure of **Example 9**, 0.139g (0.468 mmol) of the product of **Example 16** provided 0.118g (81%) of the hydroxamic acid as a white solid. Electrospray Mass Spec 312.9 (M+H)+

25

Example 18

2-[(4-Methoxy-benzenesulfonyl)-methyl-amino]-3-methyl-butyric acid

To a solution of 0.250g (0.700 mmol) of the product of **Example 5** in 1.0 mL of dichloromethane was added 0.5 mL of trifluoroacetic acid and the resulting mixture was stirred for 2h at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with a gradient of ethyl

30

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acetate/hexanes (1:3) to (1:1) to provide 0.211g (100%) of the carboxylic acid as a colorless oil. Electrospray Mass Spec 300.0 (M-H)-

Example 19

5 **N-Hydroxy-2-[(4-methoxy-benzenesulfonyl)-methyl-amino]-
 3-methyl-butyramide**

According to the procedure of **Example 9**, 0.179g (0.595 mmol) of the product of **Example 18** provided 0.156g (83%) of the hydroxamic acid as a colorless oil. Electrospray Mass Spec 316.9 (M+H)+

10

Example 20

(4-But-2-ynyloxy-benzenesulfonylamino)-acetic acid ethyl ester

To a solution of 1.00g (7.163 mmol) of glycine ethyl ester in 10 mL of chloroform and 2.0 mL of pyridine was added 1.75g (7.163 mmol) of 4-but-2-
15 ynyloxy-benzenesulfonyl chloride and the reaction was stirred at room temperature for 15h. The reaction mixture was then diluted with ether and the organics were washed with 5% HCl solution and water, dried over MgSO₄, filtered and concentrated in vacuo. The resulting brown solid was washed with ether to provide 0.96g (43%) of the sulfonamide as a white solid. Electrospray Mass Spec 311.8
20 (M+H)+

Example 21

**[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-
 acetic acid ethyl ester**

25 To a solution of 0.300g (0.965 mmol) of the product of **Example 20** in 5.0 mL of DMF was added 0.419g (3.038 mmol) of potassium carbonate followed by 0.166g (1.013 mmol) of 3-picoyl chloride hydrochloride. The resulting mixture was stirred at room temperature for 15h and then diluted with ether and water. The organics were washed with water, dried over Na₂SO₄, filtered and concentrated in
30 vacuo to give a pale yellow solid. The solid was washed with ether/hexanes (1:1) and

dried in vacuo to provide 0.334g (86%) of the N-picolyl sulfonamide as a tan solid. Electrospray Mass Spec 402.9 (M+H)+

Example 22

5 **[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-
acetic acid**

To a solution of 0.282g (0.701 mmol) of the product of **Example 21** in 7.0 mL of THF/methanol (1:1) was added 3.5 mL of a 1.0N solution of sodium hydroxide and the reaction was stirred overnight at room temperature. The reaction was then neutralized with 5% HCl solution and extracted with dichloromethane. The combined organics were dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.216g (82%) of the carboxylic acid as a pale yellow solid. Electrospray Mass Spec 375.0 (M+H)+

Example 23
2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-acetamide hydrochloride

To a 0° solution of 0.71 mL (1.412 mmol) of a 2.0M solution of oxalyl chloride in dichloromethane, diluted with 6.2 mL of dichloromethane, is added 0.109 mL (1.412 mmol) of DMF and the reaction is stirred for 15 minutes at 0°. A solution of 0.176g (0.471 mmol) of the carboxylic acid product of **Example 22**, dissolved in 1 mL of DMF, was added to the reaction and the resulting mixture is stirred for 1h at room temperature and then poured into a 0° mixture of 1.4 mL of water, 7.0 mL of THF and 1.4 mL of a 50% aqueous solution of hydroxylamine. The reaction is allowed to warm to room temperature overnight and the organics are then concentrated in vacuo. The residue is diluted with ethyl acetate, washed with water and saturated sodium bicarbonate, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.123g (67%) of the hydroxamic acid as a white solid.

To a solution of 0.119g (0.306 mmol) of the amino-hydroxamic acid
30 dissolved in 5.0 mL of dichloromethane and 5.0 mL of methanol was added 0.61 mL
(0.61 mmol) of a 1.0M solution of HCl in ether. The resulting mixture was stirred for

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1h at room temperature and then concentrated in vacuo. The residue was dissolved in 1.0 mL of dichloromethane and 10 mL of ether was added. The resulting precipitate was filtered, washed with ether and dried in vacuo to provide 0.096g (74%) of the hydrochloride salt of the amino-hydroxamic acid as a brown solid. Electrospray Mass Spec 389.9 (M+H)+

Example 24

(4-But-2-ynyloxy-benzenesulfonylamino)-acetic acid

To a solution of 0.30g (0.965 mmol) of the product of **Example 20** in 10 mL of THF/methanol (1:1) was added 4.8 mL of a 1.0N sodium hydroxide solution and the reaction was stirred overnight at room temperature and then acidified to pH 2 with 10% HCl solution. The resulting mixture was extracted with dichloromethane and the combined organics were dried over MgSO₄, filtered and concentrated in vacuo to provide 0.238g (83%) of the sulfonamide as a white solid. Electrospray Mass Spec 281.9 (M-H)-

Example 25

2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-acetamide

To a solution of 0.150g (0.505 mmol) of the product of **Example 24** dissolved in 2.7 mL of DMF was added 0.082g (0.606 mmol) of 1-hydroxybenzotriazole hydrate (HOBT) followed by 0.129g (0.672 mmol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC). The resulting mixture was stirred at room temperature for 1h and then 0.15 mL of a 50% aqueous hydroxylamine solution was added. The reaction was then stirred overnight and then diluted with ethyl acetate. The organics were washed with 5% HCl solution, water and saturated sodium bicarbonate solution and then dried over MgSO₄, filtered and concentrated in vacuo to provide 0.086g (54%) of the hydroxamic acid as a white solid. Electrospray Mass Spec 298.9 (M+H)+

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Example 26**2-(4-But-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid**

To a solution of 0.500g (4.255 mmol) D,L-valine in 40 mL of THF/water (1:1) was added 5.0 mL of triethylamine followed by 1.144g (4.681 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride and the reaction was stirred overnight at room temperature. The reaction mixture was then diluted with ethyl acetate and the organic layer was washed with water and 5% HCl solution, dried over MgSO₄, filtered and concentrated in vacuo. The solid residue was washed with ether/hexanes (1:1) to provide 0.383g (28%) of the sulfonamide as a white solid. Electrospray Mass Spec 323.9 (M-H)-

Example 27**2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-methyl-butyramide**

According to the procedure of **Example 25**, 0.189g (0.583 mmol) of the product of **Example 26** provides 0.110g (56%) of the desired hydroxamic acid as a white solid. Electrospray Mass Spec 341.0 (M+H)+

Example 28**2-(4-But-2-ynyloxy-benzenesulfonylamino)-propionic acid ethyl ester**

According to the procedure of **Example 20**, 1.00g (6.51 mmol) of D,L-alanine ethyl ester hydrochloride reacted with 1.75g (7.16 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride to provide 1.22g (58%) of the sulfonamide as a white solid. Electrospray Mass Spec: 325.9 (M+H)+

Example 29**2-(4-But-2-ynyloxy-benzenesulfonylamino)-propionic acid**

According to the procedure of **Example 24**, 0.500g (1.538 mmol) of the product of **Example 28** provided 0.457g (100%) of the carboxylic acid as a tan solid. Electrospray Mass Spec: 295.9 (M-H)-

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Example 30**2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide**

According to the procedure of **Example 25**, 0.410g (1.38 mmol) of the product of **Example 29** provided 0.287g (67%) of the hydroxamic acid as a white solid. Electrospray Mass Spec: 313.4 (M+H)+

Example 31**2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-propionic acid ethyl ester**

According to the procedure of **Example 21**, 0.500g (1.538 mmol) of the product of **Example 28** provided 0.461g (72%) of the N-3-picolyl sulfonamide as a pale yellow oil. Electrospray Mass Spec: 416.9 (M+H)+

Example 32**2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-propionic acid**

According to the procedure of **Example 22**, 0.419g (1.007 mmol) of the product of **Example 31** provided 0.39g (100%) of the carboxylic acid as a white foam. Electrospray Mass Spec: 388.9 (M+H)+

Example 33**2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-propionamide hydrochloride**

According to the procedure of **Example 23**, 0.364g (0.938 mmol) of the product of **Example 32** provided 0.149g of the hydroxamic acid N-3-picolyl hydrochloride salt as a light brown solid. Electrospray Mass Spec: 403.9 (M+H)+

Example 34**4-Amino-2,6-dimethyl-pyrimidine-5-carboxylic acid ethyl ester**

To a solution of 0.65g (6.31 mmol) of 2-aminoisobutyric acid, 0.077g of 4-dimethylaminopyridine and 7.4 mL of triethylamine in 20 mL of THF and 20 mL of

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water was added 1.68g (6.87 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride and the resulting mixture was stirred overnight at room temperature. The mixture was then diluted with ethyl acetate and washed with 5% HCl solution and water, dried over Na_2SO_4 , filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to provide 0.396g (20%) of the sulfonamide as a white solid. Electrospray Mass Spec: 309.9 (M-H)-

Example 35

2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-methyl-propionamide

According to the procedure of Example 25, 0.359g (1.154 mmol) of the product of Example 34 provided 0.193g (51%) of the hydroxamic acid as a clear glass. Electrospray Mass Spec: 327.3 (M+H)+

Example 36

(3S)-4-(4-Fluoro-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid

To a 0° solution of 1.00g (3.155 mmol) of 3-(S)-dimethylthexylsilyl-2,2-dimethyl-tetrahydro-2H-1,4-thiazine-3-carboxylate (prepared as described in PCT patent application WO9720824) in 20 mL of dichloromethane was added 0.693 mL (6.85 mmol) of 4-methylmorpholine followed by 0.606g (3.114 mmol) of 4-fluorobenzenesulfonyl chloride. The reaction was allowed to warm to room temperature and then stirred overnight. The reaction mixture was then poured into water and the organic layer was washed with water, dried over Na_2SO_4 , filtered and concentrated in vacuo. The residue was dissolved in 20 mL of methanol and the solution was heated to reflux for 1h and then concentrated in vacuo. The residue was then chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide 0.385g (40%) of the sulfonamide as a white foam. Electrospray Mass Spec 331.8 (M-H)-

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Example 37**4-(4-But-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid****4-(4-Hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid**

5 To a solution of 3.07 mL (0.041 mol) of 2-butyne-1-ol in 75 mL of DMF at room temperature was added 1.64g (0.041 mol) 60% sodium hydride. The resulting mixture was stirred for 0.5h and then a solution of 2.50g (8.197 mmol) the product of **Example 36** dissolved in 10 mL of DMF was added to the reaction. The reaction mixture was stirred overnight at room temperature and then acidified to pH 2 with
10 10% HCl solution and extracted with ether. The combined organics were then dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide 1.2g (42%) of the butynyl ether-carboxylic acid product as a tan solid (Electrospray Mass Spec 383.9 (M+H)⁺) and 0.947g of the phenol-carboxylic acid as a pale yellow oil (Electrospray
15 Mass Spec 329.9 (M-H)⁻)

Alternatively, 4-(4-But-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid may be prepared in 31% yield according to the procedure of **Example 36** using 4-but-2-ynyloxy-benzenesulfonyl chloride as the sulfonylating agent.

20

Example 38**4-(4-But-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide**

To a 0° solution of 0.75 mL (1.504 mmol) of a 2.0M solution of oxalyl
25 chloride in dichloromethane, diluted with 6.4 mL of dichloromethane, is added 0.116 mL (1.504 mmol) of DMF and the reaction is stirred for 15 minutes at 0°. A solution of 0.176g (0.501 mmol) of the butynyl ether-carboxylic acid product of **Example 37**, dissolved in 1 mL of DMF, was added to the reaction and the resulting mixture is stirred for 1h at room temperature and then poured into a 0° mixture of 1.5 mL of
30 water, 7.4 mL of THF and 1.5 mL of a 50% aqueous solution of hydroxylamine. The reaction is allowed to warm to room temperature overnight and the organics are then

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concentrated in vacuo. The residue is diluted with ethyl acetate, washed with 5% HCl solution, water and saturated sodium bicarbonate, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.168g (91%) of the hydroxamic acid as a tan solid. Electrospray Mass Spec 398.9 (M+H)+

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Example 39

4-(4-Hept-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid

According to the procedure of **Example 37**, 0.350g (1.051 mmol) of the product of **Example 36** and 0.730 mL (5.738 mmol) of 2-heptyn-1-ol provides 0.306g (63%) of the heptynyl ether-carboxylic acid as a white solid. Electrospray Mass Spec 424.0 (M-H)-

10

Example 40

4-(4-Hept-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide

According to the procedure of **Example 38**, 0.257g (0.605 mmol) of the product of **Example 39** provides 0.214g (80%) of the hydroxamic acid as a white solid. Electrospray Mass Spec 440.9 (M+H)+

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Example 41

2-(4-But-2-ynyloxy-benzenesulfonyl)-1,2,3,4-tetrahydro-isoquinoline-3-carboxylic acid hydroxyamide

To a solution of 2.00g (9.359 mmol) of 1,2,3,4-tetrahydro-3-isoquinoline-carboxylic acid hydrochloride in 70 mL of THF/water (1:1) was added 10.0 mL of triethylamine followed by 2.30g (9.407 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride and the reaction was stirred overnight at room temperature. The reaction mixture was then diluted with ethyl acetate and the organic layer was washed with water and 5% HCl solution, dried over MgSO₄, filtered and concentrated in vacuo. The solid residue was washed with ether/hexanes (1:1) to provide 2.73g (76%) of the sulfonamide as a pale yellow solid. . Electrospray Mass Spec 385.9 (M+H)+

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According to the procedure of **Example 38**, 0.736g (1.912 mmol) of the sulfonamide provides 0.503g (66%) of the hydroxamic acid as a white solid. Electrospray Mass Spec 400.9 (M+H)+

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Example 42**Methyl 3-Hydroxy-2-(4-methoxybenzenesulfonylamino)propionate****Reference Example 13 in Case# 33,315:****3-Hydroxy-2-(4-methoxy-benzenesulfonylamino)-propionic acid methyl ester**

To a mixture of 5.0g (32.14 mmol) of D, L-serine methyl ester and 15.7 mL (0.012 mol) of triethylamine in 100 mL of dichloromethane, cooled to 0°C, was added 6.64g (32.14 mmol) of 4-methoxybenzenesulfonyl chloride. The mixture was then stirred under argon at room temperature for two days. The mixture was diluted with 100 mL of dichloromethane and then washed with 60 mL each of water, 2N citric acid and brine and then dried over Na₂SO₄. The solvent was removed under vacuum to give a solid which was recrystallized from ethyl acetate to give 5.0g (54%) of the product as white crystals, m.p. 92-94°C.

Anal for C₁₁H₁₅NO₆S:

Calc'd: C,45.7; H, 5.2; N, 4.8; S, 11.1;

Found: C,45.6; H, 5.2; N, 4.8; S, 11.1;

20

Example 43**2-[(3-Chloro-propyl)-(4-methoxy-benzenesulfonyl)-amino]-3-hydroxy-propionic acid methyl ester****and****25 2-[(3-Chloro-propyl)-(4-methoxy-benzenesulfonyl)-amino]-acrylic acid methyl ester**

To a solution of 0.25g (0.865 mmol) of the sulfonamide of **Example 42** in 4.5 mL of DMF was added 0.042g (1.038 mmol) of 60% sodium hydride. The resulting mixture was stirred for 30 min at room temperature and then 0.26 mL (2.595 mmol) of 1,3-dibromopropane was added and the reaction was stirred overnight at room temperature.

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The reaction mixture was diluted with water and extracted with ether. The combined organics were washed with water and brine, dried over MgSO_4 , filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to give 0.148g (47%) of the chloro-alcohol and
5 0.049g (16%) of the acrylic acid methyl ester. Electrospray Mass Spec: 382.9 ($\text{M}+\text{NH}_4^+$) chloro-alcohol; 348.1 ($\text{M}+\text{H}$)⁺ acrylic acid methyl ester.

Example 44

2-[(3-Chloro-propyl)-(4-methoxy-benzenesulfonyl)-amino]- 10 acrylic acid methyl ester

To a solution of 1.213g (3.319 mmol) of the chloro-alcohol product of **Example 43** in 60 mL of dichloromethane was added 2.31 mL (16.59 mmol) of triethylamine followed by 0.31 mL (3.982 mmol) of methanesulfonyl chloride. The resulting mixture was stirred at room temperature for 1h and an additional 0.31 mL
15 (3.982 mmol) of methanesulfonyl chloride was then added and the reaction was stirred overnight.

The reaction was then diluted with ether, washed with 2N citric acid solution, water and brine, dried over MgSO_4 , filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give
20 0.989g (86%) of the chloro-olefin. Electrospray Mass Spec: 348.1 ($\text{M}+\text{H}$)⁺

Example 45

4-Benzyl-1-(4-methoxy-benzenesulfonyl)-[1,4]diazepane-2- 25 carboxylic acid methyl ester

To a solution of 0.910g (0.2.619 mmol) of the product of **Example 44** in 30 mL of DMF was added 0.432g (0.2.881 mmol) of sodium iodide. The reaction was stirred for 30 min at room temperature and then 0.590 mL (5.499 mmol) of benzylamine and 0.96 mL (5.499 mmol) of diisopropylethylamine was added and the resulting mixture was heated at 80 degrees for 3h and then cooled to room
30 temperature.

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The reaction was diluted with ether, washed with water and then extracted with 10% HCl solution. The combined acid extracts were then basified with 1N NaOH solution and extracted with ether. The ether layer was dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.835g (76%) of the diazepane. Electropray Mass Spec: 418.9 (M+H)⁺

Example 46

1-(4-methoxy-benzenesulfonyl)-[1,4]diazepane-2-carboxylic acid methyl ester

10

To a solution of 11.0g (0.026 mol) of the product of **Example 45** in 50 mL of ethanol was added 4.40g of 20% palladium hydroxide on carbon (Pearlman's catalyst) and the resulting suspension was shaken at room temperature in a Parr reactor under 44psi of hydrogen for 4h. The reaction mixture was then filtered through Celite and the filter cake was washed with 100 mL of methanol. The filtrate was concentrated in vacuo and the residue was diluted with ethyl acetate. The solution was washed with water, dried over Na₂SO₄, filtered and concentrated in vacuo. The resulting oil was pure enough for use in the next step. Electropray Mass Spec: 328.9 (M+H)⁺

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Example 47

4-Benzoyl-1-(4-hydroxy-benzenesulfonyl)-[1,4]diazepane-2-carboxylic acid methyl ester

To a solution of 2.576g (7.854 mmol) of the product of **Example 46** in 60 mL of dichloromethane was added 3.28 ml (0.024 mol) of triethylamine followed by 2.74 mL (0.024 mol) of benzoyl chloride and the resulting mixture was stirred at room temperature for 18h. The reaction mixture was then diluted with ether and washed with 5% citric acid solution, water and saturated sodium bicarbonate solution. The organics were dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (2:1) to provide 2.35g (69%) of the carboxamide-ester as a colorless oil.

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To a 0° solution of 1.88g (4.352 mmol) of the carboxamide-ester in 100 mL of dichloromethane was added 17.4 mL (17.4 mmol) of a 1.0M solution of boron tribromide in dichloromethane. The reaction was stirred at room temperature for 2h and then poured into an ice cold solution of saturated sodium bicarbonate. The resulting mixture was extracted with dichloromethane and the combined organics were dried over MgSO₄, filtered and concentrated in vacuo to provide 0.645g (35%) of the phenol as a white foam. Electrospray Mass Spec: 419.0 (M+H)⁺

Example 48

10 **4-Benzoyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-[1,4]diazepane-2-carboxylic acid**

To a solution of 0.096g (0.368 mmol) of triphenylphosphine in 3 mL of benzene was added 0.028 mL (0.368 mmol) of neat 2-butyne-1-ol followed by a solution of 0.123g (0.294 mmol) of the phenol product of **Example 47** dissolved in 1.0 mL of THF. To the resulting reaction mixture was added 0.058 mL (0.368 mmol) of diethylazodicarboxylate and the reaction was stirred for 15h at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to provide the butynyl ether-methyl ester.

The methyl ester was then dissolved in 6.0 mL of THF/methanol (1:1) and 1.5 mL of 1N sodium hydroxide solution was added. The reaction was stirred overnight at room temperature and then the THF/methanol was removed in vacuo. The residue was diluted with 1N sodium hydroxide solution and washed with ether, ethyl acetate and dichloromethane. The aqueous layer was acidified with 10% HCl solution and extracted with dichloromethane and these extracts were dried over MgSO₄, filtered and concentrated in vacuo to provide 0.093g (70%) of the butynyl ether-carboxylic acid as a colorless oil. Electrospray Mass Spec: 457.0 (M+H)⁺

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Example 49**4-Benzoyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-[1,4]diazepane-****2-carboxylic acid hydroxyamide**

According to the procedure of **Example 38**, 0.108g (0.238 mmol) of the
5 product of **Example 48** provides 0.067g (60%) of the hydroxamic acid as a white
foam. Electrospray Mass Spec: 472.0 (M+H)⁺

Example 50**Piperazine-1,3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester**

10 To a solution of 1.00g (6.329 mmol) of ethyl piperazine-2-carboxylate [Rissi,
E.; Jucker, E. *Helv. Chim. Acta* 1962, 45, 2383.] in 25 mL of chloroform was added
1.66g (7.595 mmol) of di-t-butyl dicarbonate followed by 0.168g of 4-
dimethylaminopyridine. The reaction was stirred at room temperature for 15h and
then concentrated in vacuo. The residue was chromatographed on silica gel eluting
15 with ethyl acetate to provide 1.63g (100%) of the t-butyl carbamate as a colorless oil.
Electrospray Mass Spec: 258.9 (M+H)⁺

Example 51**4-(4-Fluoro-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-****tert-butyl ester 3-ethyl ester**

20 To a solution of 1.35g (5.233 mmol) of the product of **Example 50** dissolved
in 20 mL of chloroform and 1.5 mL of pyridine was added 1.02g (5.233 mmol) of 4-
fluorobenzenesulfonyl chloride and the resulting mixture was stirred overnight at
room temperature. The chloroform was removed in vacuo and the residue was diluted
25 with ether and washed with water, 5% HCl solution and saturated sodium bicarbonate
solution and then dried over MgSO₄, filtered and concentrated in vacuo. The residue
was triturated with ether/hexanes (1:1) and the solid was collected by filtration and
dried in vacuo to provide 1.50g (69%) of the sulfonamide as a white solid.
Electrospray Mass Spec: 416.9 (M+H)⁺

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Example 52**1-(4-Fluoro-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester**

To a solution of 0.75g (1.803 mmol) of the product of **Example 51** in 5 mL of dichloromethane was added 2.0 mL of trifluoroacetic acid and the resulting mixture was stirred for 2h at room temperature. The reaction mixture was then concentrated in vacuo and the residue was diluted with ether. The organics were washed with saturated sodium bicarbonate solution, dried over Na_2SO_4 , filtered and concentrated in vacuo to provide 0.515g (90%) of the amine as a colorless oil pure enough for use in the next step. Electrospray Mass Spec: 316.9 (M+H)⁺

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Example 53**1-(4-Fluoro-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid ethyl ester**

To a solution of 0.469g (1.484 mmol) of the product of **Example 52** dissolved in 10 mL of DMF was added 0.614g (4.452 mmol) of potassium carbonate followed by 0.092 mL (1.484 mmol) of iodomethane and the resulting mixture was stirred at room temperature for 3h. The reaction mixture was then diluted with ether and washed with water. The organics were dried over Na_2SO_4 , filtered and concentrated in vacuo to provide 0.446g (91%) of the N-methyl amine as a colorless oil. Electrospray Mass Spec: 330.9 (M+H)⁺

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20**Example 54****1-(4-Fluoro-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid**

To a solution of 0.390 (1.182 mmol) of the product of **Example 53** dissolved in 12 mL of methanol/THF (1:1) was added 5.9 mmol of 1.0N sodium hydroxide solution and the resulting mixture was stirred for 15h at room temperature. The reaction was then brought to pH 6 with 5% HCl and extracted with dichloromethane. The organics were dried over Na_2SO_4 , filtered and concentrated in vacuo to provide 0.265g (74%) of the carboxylic acid as a pale yellow solid. Electrospray Mass Spec: 302.9 (M+H)⁺

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Example 55**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid**

To a solution of 0.302 mL (4.04 mmol) of 2-butyne-1-ol in 5.5 mL of DMF at room temperature was added 0.162g (4.04 mmol) of 60% sodium hydride. The resulting mixture was stirred for 0.5h and then a solution of 0.244g (0.808 mmol) of the product of **Example 54** dissolved in 2.0 mL of DMF was added to the reaction. The reaction mixture was then stirred at room temperature for 3h and then neutralized with 5% HCl and extracted with dichloromethane. The combined organics were then dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate to provide 0.118g (42%) of the desired butynyl ether-carboxylic acid product as a tan solid. Electrospray Mass Spec: 352.9 (M+H)+

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Example 56**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid hydroxyamide hydrochloride**

According to the procedure of **Example 38**, 0.095g (0.270 mmol) of the product of **Example 55** provides 0.080g (81%) of the amino-hydroxamic acid.

20

To a solution of 0.070g (0.191 mmol) of the amino-hydroxamic acid dissolved in 2.0 mL of dichloromethane was added 0.38 mL (0.38 mmol) of a 1.0M solution of HCl in ether. The resulting mixture was stirred for 1h at room temperature and then diluted with ether. The precipitate was filtered, washed with ether and dried in vacuo to provide 0.064g (83%) of the hydrochloride salt of the amino-hydroxamic acid as a tan solid. Electrospray Mass Spec 367.9 (M+H)+

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Example 57**4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester**

According to the procedure of **Example 51**, 1.55g (5.99 mmol) of the product of **Example 50** and 1.61g (6.59 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride

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provided 1.96g (72%) of the sulfonamide as a white solid. Electrospray Mass Spec 467.0 (M+H)+

Example 58

5 **4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid tert-butyl ester**

According to the procedure of **Example 54**, 0.400g (0.858 mmol) of the product of **Example 57** provided 0.376g (100%) of the carboxylic acid as a clear glass.

10 According to the procedure of **Example 25**, 0.472g (1.078 mmol) of the carboxylic acid provided 0.342g (70%) of the hydroxamic acid as a white foam. Electrospray Mass Spec 454.0 (M+H)+

Example 59

15 **4-(4-Hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester**

To a solution of 0.919g (2.776 mmol) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid in 20 mL of DMF was added 0.764g (9.099 mmol) of sodium bicarbonate and 0.19 mL (3.03 mmol) of iodomethane. The
20 resulting mixture was stirred for 5h at room temperature and then diluted with ether, washed with water, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.743g (78%) of the methyl ester as a pale yellow solid. Electrospray Mass Spec 345.8 (M+H)+

25 **Example 60**

2,2-Dimethyl-4-{4-[4-(tetrahydro-pyran-2-yloxy)-but-2-ynyloxy]-benzenesulfonyl}-thiomorpholine-3-carboxylic acid methyl ester

To a solution of 0.633g (2.415 mmol) of triphenylphosphine in 10 mL of benzene/THF (3:1) was added 0.410g (2.415 mmol) of 4-tetrahydropyran-2-butyn-
30 1,4-diol followed by 0.38 mL (2.415 mmol) of diethyl azodicarboxylate and 0.696g (2.017 mmol) of the product of **Example 59**. The resulting mixture was stirred at

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room temperature for 24h and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide 0.56g (56%) of the butynyl ether as a colorless oil. Electrospray Mass Spec 497.9 (M+H)+

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Example 61

4-[4-(4-Hydroxy-but-2-ynyloxy)-benzenesulfonyl]-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide

To a solution of 0.413g (0.831 mmol) of the product of **Example 60** in 10 mL of methanol/THF (1:1) was added 4.2 mL (4.20 mmol) of a 1.0N sodium hydroxide solution and the resulting mixture was heated to reflux for 5h and concentrated in vacuo. The residue was diluted with water and neutralized with 5% HCl solution. The mixture was extracted with ethyl acetate and washed with water, dried over MgSO₄, filtered and concentrated in vacuo to provide 0.335g (84%) of the carboxylic acid as a colorless oil.

To a solution of 0.270g (0.559 mmol) of the carboxylic acid dissolved in 3.0 mL of DMF was added 0.091g (0.671 mmol) of 1-hydroxybenzotriazole hydrate (HOBT) followed by 0.143g (0.743 mmol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC). The resulting mixture was stirred at room temperature for 1h and then 0.17 mL of a 50% aqueous hydroxylamine solution was added. The reaction was then stirred overnight and then diluted with ethyl acetate. The organics were washed with 5% HCl solution, water and saturated sodium bicarbonate solution and then dried over MgSO₄, filtered and concentrated in vacuo.

The residue was dissolved in 10 mL of methanol and 20 mg of pyridinium p-toluenesulfonate was added and the mixture was heated to reflux for 18h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate and the organics were washed with 5% HCl solution, water, and saturated sodium bicarbonate solution. The organics were then dried over Na₂SO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (4:1) to provide 0.073g (32%) of the hydroxamic acid alcohol as a pale yellow solid. Electrospray Mass Spec 414.9 (M+H)+

Example 62A**[(4-Hydroxy-benzenesulfonyl)-methyl-amino]-acetic acid ethyl ester**

To a solution of 1.00g (6.51 mmol) of sarcosine ethyl ester hydrochloride in
5 10 mL of chloroform was added 2.0 mL of pyridine followed by 1.25g (6.51 mmol)
of 4-hydroxybenzenesulfonyl chloride. The reaction was stirred at room temperature
for 15h and then concentrated in vacuo. The residue was diluted with ethyl acetate
and washed with 5% HCl solution and water, dried over MgSO_4 , filtered and
concentrated in vacuo to provide 1.47g (83%) of the sulfonamide-phenol as a white
10 solid. Electrospray Mass Spec 273.8 (M+H)+

Example 62B**L-2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide**

Step A: Coupling of *N*-(9-Fluorenylmethoxycarbonyl)-L-alanine to
15 hydroxylamine resin.
4-*O*-Methylhydroxylamine-phenoxyethyl-copoly(styrene-1%-divinylbenzene)-resin¹
(0.9 g, 1.1 meq/g) was placed in an empty SPE column (Jones Chromatography USA,
Inc. Part # 120-1024-H) and suspended in DMF (4 mL). *N*-(9-Fluorenylmethoxy-
carbonyl)-L-alanine (560 mg, 2.0 eq.) HOBt (730 mg, 6.0 eq.) and DIC (454 μL , 4.0
20 eq.) were added. The reaction was shaken on an orbital shaker at room temperature
for 2 - 16 hours. The reaction was filtered and washed with DMF (3 x 20 mL). A
sample of resin was removed and subjected to the Kaiser test. If the test showed the
presence of free amine (resin turned blue) the coupling described above was repeated,
otherwise the resin was washed with DCM (3 x 20 mL), MeOH (2 x 20 mL), and
25 DCM (2 x 20 mL). (A wash consisted of addition of the solvent and agitation either
by nitrogen bubbling or shaking on the orbital shaker for 1-5 minutes, then filtration
under vacuum). The resin was dried *in vacuo* at room temperature.

Step B: Removal of the *N*-(9-Fluorenylmethoxycarbonyl) protecting group.
The *N*-(9-fluorenylmethoxycarbonyl) amino hydroxamate resin prepared in Step A
30 (0.9g) was suspended in 20% piperidine in DMF (4 mL). The reaction was shaken at
room temperature for 15 minutes, then the resin was filtered and washed with DMF (1

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x 4 mL) and the deprotection repeated for 30 minutes. The reaction was filtered and washed with DMF (2 x 2 mL), MeOH (2 x 2 mL), and DCM (2 x 2 mL). The resin was dried *in vacuo* at room temperature.

Step C: Sulfonamide formation.

- 5 The amino hydroxamate resin prepared in Step B (0.9 g) was suspended in DCM (3.0 mL) and pyridine (142 μ L, 2.0 eq.) and 4-but-2-ynyloxy-benzenesulfonyl chloride (220 mg, 1.1 eq.) were added. The reaction mixture was shaken on an orbital shaker at room temperature for 12 - 24 hours. The reaction was filtered and washed with DCM (2 x 2 mL), DMF (2 x 2 mL), MeOH (2 x 2 mL), and DCM (2 x 2 mL). The resin was
- 10 dried *in vacuo* at room temperature.

Step D: Cleavage of the 4-but-2-ynyloxybenzenesulfonyl amino hydroxamate from resin.

- The 4-but-2-ynyloxybenzenesulfonyl amino hydroxamate resin prepared in Step C (300 mg) was suspended in DCM (1.0 mL) and TFA (1.0 mL) was added. The reaction
- 15 was shaken for 1 hour at room temperature. The reaction was filtered and the resin washed with DCM (2 x 1 mL). The filtrate and the washing were combined and concentrated to dryness on a Savant SpeedVac Plus. MeOH (1 mL) was added and the mixture concentrated.

- The crude product was purified by reverse phase HPLC under the following
- 20 conditions:

Column: ODS-AM, 20 mm x 50 mm, 5 μ m particle size (YMC, Inc. Wilmington, North Carolina)

Solvent Gradient: 5 - 95% acetonitrile (0.05% TFA) in water (0.05% TFA) over 16 minutes.

- 25 Flow Rate: 22.5 mL/minute.

L-2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide
(22.5 mg, 24%) had HPLC retention time² 3.59 min. and MS³ 313 (M+H).

- 30 The hydroxamic acids compounds shown in Table 1 are synthesized according to the procedures of Example 62B using the following Fmoc protected amino acids as

starting materials: Fmoc- α -Me-Ala, Fmoc-Abu, Fmoc-Ala, Fmoc-Arg, Fmoc-Arg(Ts), Fmoc-Asn, Fmoc-Asp(All), Fmoc-Asp(Chx), Fmoc- β -Ala, α -Fmoc- γ -Boc-Diaminobutyric acid, Fmoc-Cha, Fmoc-Chg, Fmoc-Cys(Bu-t), Fmoc-Cys(Mob), Fmoc-D-Asn, Fmoc-D-Orn(Boc), Fmoc-D-Cha, Fmoc-D-Chg, Fmoc-D-Leu, Fmoc-D-Met, Fmoc-D-Phe, Fmoc-D-Pro, Fmoc-D-Trp, Fmoc-D-Tyr(Bu-t), Fmoc-D-Val, Fmoc-Glu(Bu-t), Fmoc-His(Boc), Fmoc-Hyp(Bn), Fmoc-Ile, Fmoc-Leu, Fmoc-Lys(2-Cl-Bn), Fmoc-Lys(Boc), Fmoc-Nle, Fmoc-Phe, Fmoc-Cys(Acm), Fmoc-Ser(Ac), Fmoc-Ser(Bn), Fmoc-Ser(Bu-t), Fmoc-Thr(Bn), Fmoc-Thr(Bu-t), Fmoc-Trp(Boc), Fmoc-Tyr(Bu-t), Fmoc-Tyr(Bn), Fmoc-Val, Fmoc-Phg, Fmoc-Gly, Fmoc-D-Arg(Mtr), Fmoc-D-Arg(Pbf), Fmoc-D-Arg(Mtr), Fmoc-D-Asp, Fmoc-D-Cys(t-Bu), Fmoc-D-Cys(Acm), Fmoc-D-Cys(MbzI), Fmoc-D-Cys(Mob), Fmoc-D-Gln, Fmoc-D-Glu, Fmoc-D-Hfe, Fmoc-D-His, Fmoc-D-Hyp, Fmoc-D-Lys, Fmoc-D-Lys(Cbz), Fmoc-D-1-Nal, Fmoc-D-2-Nal, Fmoc-D-Nle, Fmoc-D-Nve, Fmoc-D-Orn, Fmoc-D-3,4-diF-Phe, Fmoc-D-4-F-Phe, Fmoc-D-4-nitro-Phe, Fmoc-D-Pip, Fmoc-D-Ser, Fmoc-D-Ser(Bn), Fmoc-D-2-Thi, Fmoc-D-Thr, Fmoc-D-Thr(Bn), Fmoc-D-Thz, Fmoc-D-Tic, Fmoc-D-Tyr(Bn), Fmoc-D-Phg.

Table 1

Example	Amino acid ⁴	HPLC retention time ² (min.)	MS ³ (M+H)
62B	L-Ala	3.59	313
63	L-Abu	3.73	327
64	L-Arg	3.21	398
65	L-Arg(Ts)	4.30	552
66	L-Asn	4.00	356
67	L-Asp	4.00	357
68	L-Asp(Chx)	4.73	439
69	β -Ala	3.63	313
70	L-A ₂ bu	3.12	342
71	L-Cha	4.75	395
72	L-Chg	4.41	381
73	L-Cys(t-Bu)	4.49	401
74	L-Cys(Mob)	4.76	465
75	D-Asn	3.99	356
76	D-Orn	3.10	356
77	D-Cha	4.70	395

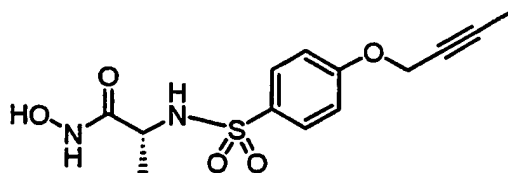
Example	Amino acid ⁴	HPLC retention time ² (min.)	MS ³ (M+H)
78	D-Chg	4.43	381
79	D-Leu	4.20	355
80	D-Met	4.00	373
81	D-Phe	4.36	389
82	D-Pro	3.90	339
83	D-Trp	4.64	428
84	D-Tyr	3.83	405
85	D-Val	3.89	341
86	L-Glu	3.92	371
87	L-His	3.06	379
88	L-Hyp(Bn)	4.67	445
89	L-Ile	4.13	355
90	L-Leu	4.21	355
91	L-Lys(2-Cl-Bn)	4.91	495
92	L-Lys	4.22	370
93	L-Nle	4.25	355
94	L-Phe	4.37	389
95	L-Phg	4.24	375
96	L-Cys(Acm)	3.56	416
97	L-Ser(Bn)	4.57	419
98	L-Ser	3.38	329
99	L-Thr(Bn)	4.69	433
100	L-Thr	3.45	343
101	L-Trp	4.33	428
102	L-Tyr	3.80	405
103	L-Tyr(Bn)	5.14	495
104	L-Val	3.87	341
295	D-Arg(Mtr)	4.72	610
296	D-Arg	3.24	398
297	D-Arg(Ts)	4.34	552
298	D-Asp	4.02	357
299	D-Cys(t-Bu)	4.54	401
300	D-Cys(Acm)	3.61	416
301	D-Cys(MbzI)	5	449
302	D-Cys(Mob)	4.76	465
303	D-Gln	3.94	370
304	D-Glu	3.94	371
305	D-Hfe	4.63	403
306	D-His	3.11	379
307	D-Hyp	3.43	355
308	D-Lys	3.18	370
309	D-Lys(Cbz)	4.75	504

Example	Amino acid ⁴	HPLC retention time ² (min.)	MS ³ (M+H)
310	D-1-Nal	4.78	439
311	D-2-Nal	4.83	439
312	D-Nle	4.3	355
313	D-Nva	4.05	341
314	D-Orn	3.15	356
315	D-3,4-diF-Phe	4.58	425
316	D-4-F-Phe	4.48	407
317	D-4-NO ₂ -Phe	4.44	434
318	D-Pip	4.26	353
319	D-Ser	3.42	329
320	D-Ser(Bn)	4.62	419
321	D-Thi	4.33	395
322	D-Thr	3.5	343
323	D-Thr(Bn)	4.75	433
324	D-Thz	4.17	357
325	D-Tic	4.63	401
326	D-Tyr(Bn)	5.19	495
327	D-Phg	4.29	375

²LC conditions: Hewlett Packard 1100; YMC ODS-A 4.6 mm x 50 mm 5 u column at 23°C; 10uL injection; Solvent A: 0.05% TFA/water; Solvent B: 0.05% TFA/acetonitrile; Gradient: Time 0: 98% A; 1 min: 98% A; 7 min: 10% A, 8 min: 10% A; 8.9 min: 98% A; Post time 1 min. Flow rate 2.5 mL/min; Detection: 220 and 254 nm DAD.

³ MS conditions: API-electrospray

⁴ Amino acid refers to the amino acid portion of the molecule, for example in Example 62B the amino acid is D-Ala.



Example 62B

Abbreviations:

- | | | |
|----|---------|--|
| 15 | Cha | cyclohexylalanine |
| | Chg | cyclohexylglycine |
| | Mob | 4-methoxybenzyl |
| | Hyp | hydroxyproline |
| | 2-Cl-Bn | 2-chlorobenzyl |
| 20 | Phg | phenylglycine |
| | Mtr | 4-methoxy-2,3,4-trimethylbenzenesulfonyl |

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	Pbf	2,2,4,6,7-pentamethyldihydrobenzofuran-5-sulfonyl
	MbzI	4-methylbenzyl
	Hfe	homophenylalanine
	Cbz	benzyloxycarbonyl
5	Nal	naphthylalanine
	Nve	norvaline
	3,4-diF-Phe	3,4-difluorophenylalanine
	4-F-Phe	4-fluorophenylalanine
	4-nitro-Phe	4-nitrophenylalanine
10	Pip	pipecolic acid
	Thi	thienylalanine
	Thz	thiazolidine-4-carboxylic acid
	Tic	tetrahydroisoquinoline-3-carboxylic acid
	Abu	-Diaminobutyric acid
15	Acm	Acetamidomethyl
	Ts	p-toluenesulfonyl
	All	allyl
	Bn	Benzyl
	Chx	Cyclohexyl
20	TFA	trifluoroacetic acid
	DCM	dichloromethane
	Fmoc	N-(9-Fluorenylmethoxycarbonyl)
	HOBt	1-hydroxybenzotriazole hydrate
	DIC	1,3-diisopropylcarbodiimide
25	EDC	1-ethyl-3(3'-dimethylaminopropyl)carbodiimide hydrochloride

Example 105

(2R,3S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-methylpentanamide

30 According to the procedure of **Example 26**, 0.5g (3.811 mmol) of D-isoleucine and 1.025g (4.192 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride provided 0.378g of the NH-sulfonamide carboxylic acid as a white solid. .
Electrospray Mass Spec 338.2 (M-H)⁺

35 According to the procedure of **Example 25**, 0.345g (1.018 mmol) of the carboxylic acid provided 0.191g of the hydroxamic acid, (2R,3S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-methylpentanamide, as a white solid. Electrospray Mass Spec 355.2 (M+H)⁺

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Example 106**(2R)-2-([4-(2-butyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3,3-dimethylbutanamide**

According to the procedure of **Example 26**, 0.422g (3.216 mmol) of D-*tert*-leucine and 0.865g (3.538 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride provided 0.532g of the NH-sulfonamide carboxylic acid as a white solid. Electropray Mass Spec 338.3 (M-H)⁻

According to the procedure of **Example 25**, 0.472g (1.392 mmol) of the carboxylic acid provided 0.131g of the hydroxamic acid, (2R)-2-([4-(2-butyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3,3-dimethylbutanamide, as a white solid. Electropray Mass Spec 355.2 (M+H)⁺

Example 107**(2S)-2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-propionamide**

According to the procedure of **Example 20**, 0.500g (3.58 mmol) of D-alanine methyl ester hydrochloride and 0.877g (3.58 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride provided 0.532g of the NH-sulfonamide ester, (2R)-2-(4-but-2-ynyloxy-benzenesulfonylamino)-propionic acid methyl ester, as a white solid. Electropray Mass Spec 312.1 (M+H)⁺

According to the procedure of **Example 21**, 0.30g (0.971 mmol) of (2R)-2-(4-but-2-ynyloxy-benzenesulfonylamino)-propionic acid methyl ester provided 0.31g of (2R)-2-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-propionic acid methyl ester as a colorless oil. Electropray Mass Spec 326.2 (M+H)⁺

To a solution of 0.273g (0.840 mmol) of (2R)-2-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-propionic acid methyl ester in 6 mL of THF/methanol (1/1) was added 0.123g (2.94 mmol) of lithium hydroxide monohydrate and the resulting solution was stirred at room temperature for 3h. The reaction was then acidified with 5% HCl solution and extracted with chloroform. The combined organics were dried over MgSO₄, filtered and concentrated in vacuo to give 0.256g of 2-[(4-

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but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-propionic acid as a white solid. Electrospray Mass Spec 310.2 (M-H)⁺

According to the procedure of **Example 25**, 0.220g (0.707 mmol) of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-propionic acid provided 0.172g of
5 (2S)-2-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-propionamide as a white solid. Electrospray Mass Spec 327.2 (M+H)⁺

Example 108

10 2-[(4-But-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-N-hydroxy-3-methyl-butylamide

According to the procedure of **Example 20**, 1.500g (8.95 mmol) of D,L-valine methyl ester hydrochloride and 2.19g (8.95 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride provided 2.15g of the NH-sulfonamide ester, 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester, as a white solid.

15 According to the procedure of **Example 5**, 0.350g (1.032 mmol) of 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester and 0.25 mL (3.097 mmol) of iodoethane provided 0.334g of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-3-methyl-butyric acid methyl ester as a white solid. Electrospray Mass Spec 368.4 (M+H)⁺

20 According to the procedure of **Example 11**, 0.304g (0.828 mmol) of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-3-methyl-butyric acid methyl ester provided 0.273g of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-3-methyl-butyric acid as a white solid. Electrospray Mass Spec 352.2 (M-H)⁻

25 According to the procedure of **Example 9**, 0.232g (0.657 mmol) of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-3-methyl-butyric acid provided 0.235g of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-N-hydroxy-3-methyl-butylamide as an off-white solid. Electrospray Mass Spec 369.3 (M+H)⁺

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Example 109**2-[[4-(2-Butynyloxy)phenyl]sulfonyl](2-propynyl)amino]-N-hydroxy-3-methylbutanamide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and propargyl bromide, 2-[[4-(2-butynyloxy)phenyl]sulfonyl](2-propynyl)amino]-N-hydroxy-3-methylbutanamide was obtained as a white foam. Electrospray Mass Spec 379.4 (M+H)⁺

Example 110**2-[(4-But-2-ynyloxy-benzenesulfonyl)-propyl-amino]-N-hydroxy-3-methyl-butyramide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and propyl iodide, 2-[(4-but-2-ynyloxy-benzenesulfonyl)-propyl-amino]-N-hydroxy-3-methyl-butyramide was obtained as a white solid. Electrospray Mass Spec 383.2 (M+H)⁺

Example 111**2-[(4-But-2-ynyloxy-benzenesulfonyl)-(3-phenyl-propyl)-amino]-N-hydroxy-3-methyl-butyramide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and 1-bromo-3-phenylpropane, 2-[(4-but-2-ynyloxy-benzene-sulfonyl)-(3-phenyl-propyl)-amino]-N-hydroxy-3-methyl-butyramide was obtained as a white solid. Electrospray Mass Spec 459.2 (M+H)⁺

25

Example 112**2-[(4-But-2-ynyloxy-benzenesulfonyl)-cyclopropylmethyl-amino]-N-hydroxy-3-methyl-butyramide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and (bromomethyl)cyclopropane, 2-[(4-but-2-ynyloxy-benzene-sulfonyl)-cyclopropylmethyl-amino]-N-hydroxy-3-methyl-butyramide was obtained as a white solid. Electrospray Mass Spec 395.3 (M+H)⁺

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Example 113**2-[(4-But-2-ynyloxy-benzenesulfonyl)-isobutyl-amino]-N-hydroxy-3-methyl-butylamide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and 2-methyl-1-iodopropane, 2-[(4-but-2-ynyloxy-benzene-sulfonyl)-isobutyl-amino]-N-hydroxy-3-methyl-butylamide was obtained as a white solid. Electrospray Mass Spec 397.2 (M+H)⁺

Example 114**2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-3-methyl-butylamide**

According to the procedure of **Example 108**, starting from D, L-valine methyl ester hydrochloride and 3-picolyl chloride hydrochloride, 2-[(4-but-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-3-methyl-butylamide was obtained as a white solid. Electrospray Mass Spec 432.2 (M+H)⁺

Example 115**2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-2-cyclohexyl-N-hydroxy-acetamide**

According to the procedure of **Example 107**, starting from D-cyclohexyl-glycine methyl ester hydrochloride and iodomethane, 2-[(4-but-2-ynyloxy-benzene-sulfonyl)-methyl-amino]-2-cyclohexyl-N-hydroxy-acetamide was obtained as a white solid. Electrospray Mass Spec 395.2 (M+H)⁺

25

Example 116**2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-2-cyclohexyl-N-hydroxy-acetamide**

According to the procedure of **Example 107**, starting from D-cyclohexylglycine methyl ester hydrochloride and 3-picolyl chloride hydrochloride, 2-[(4-but-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-2-cyclohexyl-N-hydroxy-acetamide was obtained as a tan solid. Electrospray Mass Spec 472.3 (M+H)⁺

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Example 117**2-{{(4-But-2-ynyloxy-benzenesulfonyl)-[4-(2-piperidin-1-yl-ethoxy)-benzyl]-amino}-2-cyclohexyl-N-hydroxy-acetamide**

According to the procedure of **Example 107**, starting from D-cyclohexyl-glycine methyl ester hydrochloride and 4-(2-piperidin-1-yl-ethoxy)-benzyl chloride (U.S. Patent 5,929,097), 2-{{(4-but-2-ynyloxy-benzenesulfonyl)-[4-(2-piperidin-1-yl-ethoxy)-benzyl]-amino}-2-cyclohexyl-N-hydroxy-acetamide was obtained as a white solid. Electrospray Mass Spec 598.3 (M+H)⁺

10

Example 118**2-{{{4-(2-Butynyloxy)phenyl]sulfonyl}[3-(diethylamino)propyl]amino}-N-hydroxy-3-methylbutanamide**

According to the procedure of **Example 5**, 1.00g (2.95 mmol) 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester and 0.88 mL (8.849 mmol) of 1-bromo-3-chloropropane provided 0.92g of methyl-2-[[[4-(2-butynyloxy)-phenyl]sulfonyl](3-chloropropyl)amino]-3-methylbutanoate as a white solid. Electrospray Mass Spec 416.2 (M+H)⁺

To a solution of 0.45g (1.08 mmol) of methyl 2-[[[4-(2-butynyloxy)-phenyl]sulfonyl](3-chloropropyl)amino]-3-methylbutanoate in 5.0 mL of DMF was added 0.163g (1.08 mmol) of sodium iodide and 0.34 mL (3.24 mmol) of diethylamine. The reaction was heated to 80°C for 3h and then cooled to room temperature. The mixture was then diluted with water and extracted with ethyl acetate. The combined organics were washed with water and brine, dried over Na₂SO₄, filtered and concentrated in vacuo to provide 0.441g of methyl 2-[[[4-(2-butynyloxy)-phenyl]sulfonyl][3-(diethylamino)propyl]amino]-3-methylbutanoate as a brown oil. Electrospray Mass Spec 453.5 (M+H)⁺

According to the procedure of **Example 11**, 0.412g (0.912 mmol) of methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl][3-(diethylamino)propyl]amino]-3-methylbutanoate provided 0.368g of N-[[[4-(2-butynyloxy)phenyl]sulfonyl]-N-[3-(diethylamino)propyl]valine as a tan foam. Electrospray Mass Spec 439.4 (M+H)⁺

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According to the procedure of **Example 9**, 0.338g (0.772 mmol) of of N-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-[3-(diethylamino)propyl]valine provided 0.223g of 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[3-(diethylamino)propyl]amino}-N-hydroxy-3-methylbutanamide as a brown foam. Electrospray Mass Spec 369.3 (M+H)⁺

5

Example 119**2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-morpholinyl)propyl]amino}-N-hydroxy-3-methylbutanamide**

According to the procedure of **Example 118**, using morpholine instead of
10 diethylamine, 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}(3-chloropropyl)amino]-3-methylbutanoate was converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[3-(4-morpholinyl)propyl]amino}-N-hydroxy-3-methylbutanamide, obtained as a white foam.
Electrospray Mass Spec 468.4 (M+H)⁺

15

Example 120**2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-methyl-1-piperazinyl)propyl]amino}-N-hydroxy-3-methylbutanamide hydrochloride**

According to the procedure of **Example 118**, using 1-methylpiperazine instead of diethylamine, 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}(3-chloropropyl)-
20 amino]-3-methylbutanoate was converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[3-(4-methyl-1-piperazinyl)propyl]amino}-N-hydroxy-3-methylbutanamide, which was converted into the corresponding hydrochloride salt with ethereal HCl solution to provide an off-white solid. Electrospray Mass Spec 481.4 (M+H)⁺

25

Example 121**2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)butyl]amino}-N-hydroxy-3-methylbutanamide**

According to the procedure of **Example 118**, using 1-bromo-4-chlorobutane instead of 1-bromo-3-chlorobutane, 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-
30 methyl-butyric acid methyl ester was converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(diethylamino)butyl]amino}-N-hydroxy-3-methylbutanamide, which was

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converted into the corresponding hydrochloride salt with ethereal HCl solution to provide a brown solid. Electrospray Mass Spec 468.2 (M+H)⁺

Example 122

5 **2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)butyl]amino}-N**
 -hydroxy-3-methylbutanamide

According to the procedure of **Example 118**, using 1-bromo-4-chlorobutane instead of 1-bromo-3-chlorobutane and 1-methylpiperazine instead of diethylamine, 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester was
10 converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-butyl]amino}-N-hydroxy-3-methylbutanamide, which was converted into the corresponding hydrochloride salt with ethereal HCl solution to provide a brown solid. Electrospray Mass Spec 495.2 (M+H)⁺

15

Example 123

2-[[[4-(2-Butynyloxy)phenyl]sulfonyl][2-(4-morpholinyl)ethyl]amino]-N-
 hydroxy-3-methylbutanamide

According to the procedure of **Example 21**, 0.419g (1.236 mmol) of 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester and 0.408g (2.20
20 mmol) of 4-(2-chloroethyl)morpholine hydrochloride provided 0.506g of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-(2-morpholin-4-yl-ethyl)-amino]-3-methyl-butyric acid methyl ester as a colorless oil. Electrospray Mass Spec 453.0 (M+H)⁺

According to the procedure of **Example 11**, 0.469g (1.04 mmol) of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-(2-morpholin-4-yl-ethyl)-amino]-3-methyl-butyric acid
25 methyl ester provided 0.245g of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-(2-morpholin-4-yl-ethyl)-amino]-3-methyl-butyric acid as a white solid. Electrospray Mass Spec 438.9 (M+H)⁺

According to the procedure of **Example 9**, 0.243g (0.554 mmol) of 2-[(4-but-2-ynyloxy-benzenesulfonyl)-(2-morpholin-4-yl-ethyl)- amino]-3-methyl-butyric acid
30 provided 0.105g of 2-[[[4-(2-butynyloxy)phenyl]sulfonyl][2-(4-morpholinyl)ethyl]-amino]-N-hydroxy-3-methylbutanamide, which was converted into the corresponding

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hydrochloride salt with ethereal HCl solution to give 0.105g of 2-[[[4-(2-butynyloxy)phenyl]sulfonyl][2-(4-morpholinylethyl)amino]-N-hydroxy-3-methylbutanamide hydrochloride as a white solid. Electrospray Mass Spec 454.0 (M+H)⁺

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Example 124**2-[[[4-(But-2-ynyloxy)phenyl]sulfonyl](2-morpholin-4-ylethyl)amino]-N-hydroxyacetamide hydrochloride**

According to the procedure of **Example 123**, (4-but-2-ynyloxy-benzene-sulfonylamino)-acetic acid ethyl ester provided 2-[[[4-(but-2-ynyloxy)phenyl]sulfonyl](2-morpholin-4-ylethyl)amino]-N-hydroxyacetamide hydrochloride as an off-white solid. Electrospray Mass Spec 412.3 (M+H)⁺

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Example 125**2-[[[4-(2-Butynyloxy)phenyl]sulfonyl][4-(4-methyl-1-piperazinyl)-2-butynyl]amino]-N-hydroxy-3-methylbutanamide**

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According to the procedure of **Example 5**, 0.800g (2.36 mmol) of 2-(4-but-2-ynyloxy-benzenesulfonylamino)-3-methyl-butyric acid methyl ester and 0.53g (4.72 mmol) of 80% propargyl bromide gave 0.89g of methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](2-propynyl)amino]-3-methylbutanoate as a colorless oil. Electrospray Mass Spec 378.2 (M+H)⁺

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To a solution of 0.500g (1.326 mmol) of methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](2-propynyl)amino]-3-methylbutanoate in 4.0 mL of dioxane was added 0.099g (3.316 mmol) of paraformaldehyde, 5mg of cuprous chloride, 0.5 mL of acetic acid and 0.294 ml (2.652 mmol) of 1-methylpiperazine. The resulting mixture was stirred at room temperature for 15 minutes after which the reaction had turned green. The reaction was then heated to reflux for 2h, after which the reaction had turned brown. The reaction mixture was cooled to room temperature and extracted with ether. The combined organics were washed with saturated sodium bicarbonate solution, dried over Na₂SO₄, filtered and concentrated in vacuo to give 0.649g of methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl]-4-(4-methyl-1-piperazin-

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yl)-2-butynyl]amino}-3-methylbutanoate as a brown oil. Electrospray Mass Spec 490.3 (M+H)⁺

According to the procedures of **Examples 11** and **9** methyl 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-3-methylbutanoate provided the hydroxamic acid 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide as a white solid. This was converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide hydrochloride with ethereal HCl solution to give the product as a brown powder. Electrospray Mass Spec 491.3 (M+H)⁺

Example 126

2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide

To a solution of 1.00g (2.653 mmol) of methyl 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}(2-propynyl)amino]-3-methylbutanoate in 8.0 mL of dioxane was added 0.198g (6.632 mmol) of paraformaldehyde, 10mg of cuprous chloride, 1.0 mL of acetic acid and 0.55 ml (5.305 mmol) diethylamine. The resulting mixture was stirred at room temperature for 15 minutes after which the reaction had turned green. The reaction was then heated to reflux for 2h, after which the reaction had turned brown. The reaction mixture was cooled to room temperature and extracted with ether. The combined organics were washed with saturated sodium bicarbonate solution, dried over Na₂SO₄, filtered and concentrated in vacuo to give 1.23g of methyl 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-3-methylbutanoate as a brown oil.

Methyl 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-3-methylbutanoate was converted into 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide hydrochloride, isolated as a brown foam, according to the procedures of **Examples 11** and **9**. Electrospray Mass Spec 464.5 (M+H)⁺

Example 127**2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(methylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide**

To a 0° solution of 0.689g (1.491 mmol) of methyl 2-{{[4-(2-butynyloxy)-
5 phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-3-methylbutanoate in 12 mL of diethyl ether was added 0.60 mL of a 3.0M solution of cyanogen bromide in dichloromethane. The reaction was allowed to warm to room temperature and stirred overnight. The resulting mixture was diluted with ether, washed with 5% HCl and brine, dried over Na₂SO₄, filtered and concentrated in vacuo to provide the crude
10 propargylic bromide.

The bromide was dissolved in 7.0 mL of THF and 7.0 mL of a 2.0M solution of methylamine in THF was added. The resulting mixture was stirred at room temperature overnight and then diluted with ethyl acetate and saturated sodium bicarbonate solution. The organics were dried over Na₂SO₄, filtered and concentrated
15 in vacuo. The residue was then dissolved in 10.0 mL of DMF and 0.39g of di-*t*-butyldicarbonate and 0.039g of 4-dimethylaminopyridine was added. The reaction was again stirred overnight at room temperature and then diluted with water and extracted with ether. The combined organics were washed with water, dried over Na₂SO₄, filtered and concentrated in vacuo to provide methyl 2-{{[4-(2-butynyloxy)phenyl]-
20 sulfonyl}[4-(methylamino)-2-butynyl]amino}-3-methylbutanoate.

The carbamate was dissolved in 3.2 mL of THF/MeOH (1:1) and 1.6 mL of a 1.0N NaOH solution was added. The reaction was heated to reflux for 15h and then cooled, neutralized with 5% HCl solution and extracted with dichloromethane. The organics were dried over Na₂SO₄, filtered and concentrated in vacuo to provide
25 0.157g of 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(methylamino)-2-butynyl]amino}-3-methylbutanoic acid.

According to the procedure of Example 25, 0.143g (0.283 mmol) of 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(methylamino)-2-butynyl]amino}-3-methylbutanoic acid was converted into 0.079g of the hydroxamic acid, 2-{{[4-(2-butynyloxy)phenyl]-
30 sulfonyl}[4-(methylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide, obtained as a brown solid. Electrospray Mass Spec 422.3 (M+H)⁺

Example 128

((2R)-{[4-(2-Butynyloxy)phenyl]sulfonyl}(methylamino)[(4-diethylamino)cyclohexyl]-N-hydroxyethamide

To a solution of D-4-hydroxy phenylglycine dissolved in 3N NaOH was added
5 Raney nickel (6.75g) and water (45 mL)and the mixture was then hydrogenated on a Parr hydrogenator at 50- 80°C for 24h at 40psi of hydrogen. The reaction mixture was filtered through Celite, washed with dioxane, filtered and concentrated to 20 mL. An additional 20mL of dioxane was added and the reaction was cooled to 0° C and triethylamine (2.72mL, 19.4mmol) was added, followed by 4-(2-butynyloxy)-
10 benzenesulfonyl chloride (3.21g , 13.2mmol). The mixture was stirred at room temperature overnight and then concentrated in vacuo. The residue was dissolved in water and neutralized with 1N HCl to pH 2-3. The precipitated white solid was filtered to provide 2.8g of (2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}amino)(4-hydroxycyclohexyl)ethanoic acid. mp 90-100°C. Electrospray Mass Spec 382.1 (M+H)⁺

15 To a solution of (2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}amino)(4-hydroxycyclohexyl)ethanoic acid (0.39g, 1.0 mmol) in 3 mL of DMF was added iodomethane (0.14 mL, 2.2 mmol) and potassium carbonate (0.69g, 5mmol) and the resulting mixture was stirred at room temperature overnight. The reaction was then diluted with ethyl acetate and the organic layer was washed with water and brine, dried over sodium
20 sulfate, filtered, and concentrated. Chromatography on silica gel eluting with hexane:ethyl acetate (3:7) provided 0.05g of the cis -isomer as an oil, Electrospray Mass Spec 410.2 (M+H)⁺; and 0.28g of the trans-isomer as a white solid. mp 94-96°C. Electrospray Mass Spec 410.3 (M+H)⁺.

To a solution of a 1:5 mixture of (cis)- and (trans)-methyl (2R)-{[4-(2-
25 butynyloxy)phenyl]sulfonyl}(methylamino)(4-hydroxycyclohexyl)ethanoate (0.65g, 0.159mmol) in dichloromethane (2 mL) was added Dess-Martin periodinane (0.75g, 1.77 mmol) and the reaction was stirred at room temperature for 1h. The mixture was diluted with 50 mL of ether and poured into 1N NaOH (20 mL) and stirred until the solid disappeared. The ether was washed with 20 mL of 1N NaOH, water and brine,
30 dried over sodium sulfate, filtered, and concentrated to obtain 0.61g of methyl (2R)-

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{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino)(4-oxocyclohexyl)ethanoate.

Electrospray Mass Spec 408.2 (M+H)⁺.

To a solution of methyl ((2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)-
amino)(4-oxocyclohexyl)ethanoate (0.54g, 1.32 mmol) dissolved in 4 mL of 1,2
5 dichloroethane was added diethylamine (0.097mL, 0.93mmol) and the reaction was
stirred at room temperature overnight. Sodium triacetoxyborohydride (0.49g, 2.32
mmol) was then added, followed by acetic acid (0.078g, 1.32 mmol). The mixture was
stirred at room temperature overnight. The reaction was then concentrated in vacuo
and the residue was diluted with ethyl acetate and washed with saturated NaHCO₃. The
10 ethyl acetate was washed with 1N HCL and the aqueous layer was neutralized with 5N
NaOH to pH ~ 8-9, and then extracted with CH₂Cl₂. The organic layer was washed
with water and brine, dried over sodium sulfate, filtered, and concentrated to provide
0.18g of methyl ((2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino)[(4-
diethylamino)cyclohexyl]ethanoate. Electrospray Mass Spec 465.5 (M+H)⁺.

15 To a solution of methyl ((2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)-
amino)[(4-diethylamino)cyclohexyl]ethanoate (0.15g, 0.32 mmol) in 2.0 mL of THF
was added 1N NaOH (0.40 mL) and 2 mL of methanol and the mixture was heated to
~ 55°C overnight. The reaction was concentrated in vacuo to give 0.17g of ((2R)-{[4-
(2-butynyloxy)phenyl]sulfonyl}(methyl)amino)[(4-diethylamono)cyclohexyl]-ethanoic
20 acid, sodium salt. Electrospray Mass Spec 451.4 (M+H)⁺.

According to the procedure of Example 9, ((2R)-{[4-(2-butynyloxy)phenyl]-
sulfonyl}(methyl)-amino)[(4-diethylamono)cyclohexyl]-ethanoic acid, sodium salt was
converted into the hydroxamic acid, ((2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}-
(methyl)amino)[(4-diethylamino)cyclohexyl]-N-hydroxy-ethamide. Electrospray Mass
25 Spec 466.4 (M+H)⁺.

Example 129

**((2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}amino-N-hydroxy-2-(4-
hydroxycyclohexyl)ethanamide**

30 To a mixture of (cis)- and (trans)-((2R)-{[4-(2-butynyloxy)phenyl]-sulfonyl}-
amino)(4-hydroxycyclohexyl)ethanoic acid from **Example 128** (0.57g, 1.5mmol) was

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added *t*-butyldimethylsilyl chloride (0.56g, 3.6 mmol), imidazole (0.5g 7.5 mmol) and DMF (4 mL) and the mixture was stirred at room temperature overnight. After removing the solvent, the resulting oil was extracted with ether and water. The ether layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated to provide 0.78g of *tert*-butyl(dimethyl)silyl(2R)-{[4-(2-butyloxy)-phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl)ethanoate. Yield 85.2%. Electrospray Mass Spec 610.2 (M+H)⁺.

To a solution of *tert*-butyl(dimethyl)silyl(2R)-{[4-(2-butyloxy)phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl)ethanoate (0.76g, 1.24 mmol) in 8 mL of THF/methanol (1:1) was added 1 N NaOH (1.25 mL, 1.25 mmol) and the reaction was stirred at room temperature overnight. Reducing the solvent to one quarter volume, then adding brine, the aqueous layer was neutralized with 1M KHSO₄ to pH~4 and then extracted with ethyl acetate. The combined organics were washed with water and brine, dried over sodium sulfate, filtered, and concentrated to obtain 0.68g of (2R)-{[4-(2-butyloxy)phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl) ethanoic acid. Electrospray Mass Spec 494.2 (M-H)⁻.

To a solution of (2R)-{[4-(2-butyloxy)phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl) ethanoic acid (0.62g 1.25 mmol) and 1-(3-dimethyl aminopropyl) 3- ethyl carbodimide (0.39g, 1.67 mmol) in DMF (7 mL), was added 1-hydroxybenzotriazole (0.23g, 1.50 mmol) and the reaction was stirred at room temperature for 2h. Hydroxylamine (0.54 mL of 50 % in water, 8.75 mmol) was added and the reaction was stirred overnight. The solvent was removed in vacuo and the residue was diluted with ethyl acetate and water. The organic layer was washed with saturated NaHCO₃ and water, dried over Na₂SO₄ and concentrated. The residue was purified by using preparative TLC to obtain 0.3g of (2R)-{[4-(2-butyloxy)phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl)-N-hydroxyethanamide as an off-white solid. mp 125°C (d). Electrospray Mass Spec 511.2 (M+H)⁺.

To a solution of (2R)-{[4-(2-butyloxy)phenyl]sulfonyl}amino(4-{[*tert*-butyl(dimethyl)silyl]oxy}-cyclohexyl)-N-hydroxyethanamide (0.11g, 0.21 mmol) in 2.5 mL of acetonitrile, cooled in an ice bath, was added 1 mL of 8% HF in acetonitrile.

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After a couple of minutes, a solid precipitated. The reaction was diluted with dichloromethane and water and filtered to give a white solid 0.06g. The dichloromethane layer was washed with water and brine, dried over sodium sulfate, filtered, and concentrated to provide an additional 0.02g of (2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}amino-N-hydroxy-2-(4-hydroxycyclohexyl)ethanamide.
mp 180-182°C. Electrospray Mass Spec 397.2 (M+H)⁺.

Example 130

(2R)-{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino)-N-hydroxy-2-(4-hydroxycyclohexyl)-ethanamide

According to the procedure in Example 129, (trans)-methyl (2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino)(4-hydroxycyclohexyl)ethanoate (from Example 128) was converted into (2R)-{[4-(2-butynyloxy)phenyl]sulfonyl}-(methyl)-amino)-N-hydroxy-2-(4-hydroxycyclohexyl)-ethanamide. Mp 195-197°C.
Electrospray Mass Spec 411.2 (M+H)⁺.

Example 131

2-[(6-But-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-N-hydroxy-acetamide

In a 250mL three neck round bottom flask equipped with an overhead stirrer was charged 27mL water, and cooled to -3° C (ice/NaCl). Thionyl chloride (4.52mL, 61.96mmol, 4.5eq) was added slowly so the temperature did not exceed 7° C. The ice bath was removed, allowed to warm to room temperature, then 0.07g (0.69mmol, 0.05 eq) of copper (I) chloride was added. The mixture was then recooled to -5°

5-Amino-2-chloropyridine (1.77g, 13.67mmol) was dissolved in 14 mL of concentrated HCl and cooled to -5° C to which a solution of 1.04g (15.14 mmol, 1.1eq) NaNO₂ in 12mL of water was added slowly so the temperature was maintained between -5 and 0°C. This mixture was then added to the thionyl chloride/water/CuCl mixture. A frothing precipitate resulted and was allowed to stir for another 30 min. The product was filtered and air dried. Solids were taken up in ethyl acetate, washed with brine, dried over MgSO₄ and concentrated in vacuo to afford 1.7g (62%) of 6-

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chloro-pyridine-3-sulfonyl chloride as a light tan solid. Electrospray Mass Spec 210.9 (M+H)⁺

To a solution of 6-chloro-pyridine-3-sulfonylchloride (5.15g , 24.3mmol) in 50 mL of anhydrous chloroform, 7.4 mL of pyridine and 8.82g (48.6mmol, 2eq) of
5 sarcosine hydrochloride were added and the reaction proceeded overnight at room temperature. The solvent was removed in vacuo, diluted with water, neutralized with sodium bicarbonate and extracted with ethyl acetate which was then washed with brine, dried over MgSO₄, directly preadsorbed onto silica gel and purified via flash chromatography using 5:1 Hex:EtOAc to afford 3.97g (51%) of [(6-chloro-pyridine-3-
10 sulfonyl)-methyl-amino]-acetic acid tert-butyl ester. Electrospray Mass Spec 321.1 (M+H)⁺

To a solution of 0.77mL (19.3mmol) of 2- butyn1-ol and 0.18g (4.37mmol) of sodium hydroxide were heated at 100° C for one hour. [(6-chloro-pyridine-3-sulfonyl)-methyl-amino]-acetic acid tert-butyl ester (1.0g, 3.12mmol) was added to this solution.
15 Additional butynol was added to facilitate stirring, and the reaction was stirred at 100° C overnight. The reaction was cooled, diluted with water, and washed with ethyl acetate. The aqueous layer was acidified with 2N HCl, and extracted with ethyl acetate (2x). The combined organics were washed with brine, dried over MgSO₄, concentrated to solids which were slurried in 1:1:1 dichloromethane: hexane:ethyl
20 acetate to afford 0.41g (45%) of [(6-but-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-acetic acid as an off-white solid. Electrospray Mass Spec 299.0 (M+H)⁺

In an oven dried 50mL round bottom flask was combined 0.228g (0.579 mmol)) [(6-but-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-acetic acid in 5mL of anhydrous dichloromethane and 0.22mL DMF and the mixture was cooled to 0° C.
25 Oxalyl chloride (1.45mL, 2.9mmol, 3.5eq) was slowly added to the cold solution, the ice bath was removed and the reaction let warm to room temperature for 45min. The solvent was then removed in vacuo and the residue was dissolved in 5 mL of dichloromethane and dropwise added to a solution of 0.46g hydroxylamine hydrochloride, 1.2mL DMF, 1.2mL triethylamine, 8mL dichloromethane and 8mL
30 acetonitrile. After stirring overnight at room temperature, the solvent was removed in vacuo, diluted with water and neutralized. The solids in the mixture were filtered and

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dried in vacuo. Reverse phase HPLC afforded .084g (39%) of 2-[(6-but-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-N-hydroxy-acetamide. Electrospray Mass Spec 314.3 (M+H)⁺

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Example 132**2-[[[(4-{[3-(4-Chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]-N-hydroxyacetamide**

To a solution of 4-(3-bromo-prop-1-ynyl)-phenol (5.0g, 30.12 mmol) dissolved in dichloromethane, 8.3g (31.63mmol, 1.05 eq) of triphenylphosphine was added and the solution was cooled to 0° C. Bromine (1.55mL, 30.12mmol, 1.0 eq) was added dropwise and the reaction was warmed to room temperature. The reaction was then diluted with dichloromethane, washed with sodium hydrosulfite pentahydrate, washed with brine, dried over MgSO₄ and concentrated. The residue was purified via flash chromatography using 4:1 hexane:ethyl acetate to afford 5.56g (80%) of 1-(3-bromo-prop-1-ynyl)-4-chloro-benzene as an amber oil. Electrospray Mass Spec 280.4 (M+H)⁺

To a solution of 4-hydroxybenzenesulfonic acid sodium salt (2.81g, 12.11mmol) in 50 mL of isopropyl alcohol, 11.8mL 2N NaOH and 5.56g (24.2mmol, 2 eq) of 1-(3-bromo-prop-1-ynyl)-4-chloro-benzene was added. The solution was heated to 70°C overnight. The reaction was cooled, concentrated in vacuo, filtered and air dried to afford 2.8g (67%) of 4-[3-(4-chloro-phenyl)-prop-2-ynyloxy]-benzenesulfonic acid, sodium salt. Electrospray Mass Spec 321.3 (M-H)⁻

To a solution of the crude 4-[3-(4-chloro-phenyl)-prop-2-ynyloxy]-benzenesulfonic acid sodium salt (2.81g, 8.7 mmol) was added 2.8g of phosphorous pentachloride and 50 mL of dichloromethane. The reaction warmed to 40° followed by dissolution of the reagents. The reaction was then quenched with ice, extracted with dichloromethane, washed with water, brine, dried over magnesium sulfate, filtered and concentrated in vacuo. The resulting oil was purified via flash chromatography using 20:1 Hex:EtOAc to afford 0.5g (17%) of 4-[3-(4-chloro-phenyl)-prop-2-ynyloxy]-benzenesulfonyl chloride.

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A solution of 0.57g (1.67mmol) of 4-[3-(4-chloro-phenyl)-prop-2-ynyloxy]-benzenesulfonyl chloride and 0.61g (3.34mmol, 2eq) of sarcosine t-butyl ester hydrochloride in 0.51mL of pyridine and 15mL of chloroform was allowed to react overnight at room temperature. The reaction was concentrated in vacuo, , diluted with water/ethyl acetate, neutralized with NaHCO₃ and extracted with EtOAc (2x). The combined organics were washed with brine, dried over MgSO₄, filtered and concentrated to afford a yellow oil which was purified via flash chromatography using 6:1 hexane: ethyl acetate to afford 0.396g (53%) of *tert*-butyl [[[4-{[3-(4-chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]acetate as a white solid.

Electrospray Mass Spec 450.4 (M+H)+

To a solution of *tert*-butyl [[[4-{[3-(4-chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]acetate (0.331g, 0.736mmol in methanol/THF was added 1.23mL (3.5eq) of a 1.0N solution of LiOH and the reaction was stirred at room temp overnight. The solvent was removed in vacuo and the residue was suspended in water, adjusted to pH to 3 with 2N HCl. The resulting solid was rinsed with ether and dried in vacuo to afford 0.27g (89%) of [[[4-{[3-(4-chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]acetic acid. Electrospray Mass Spec 392.1 (M+H)+

A solution of [[[4-{[3-(4-chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]acetic acid (0.231g, 0.586mmol) was converted to the desired hydroxamic acid as described in **Example 131**, to give 2-[[[4-{[3-(4-chlorophenyl)-2-propynyl]oxy}phenyl)sulfonyl](methyl)amino]-N-hydroxyacetamide after reverse phase HPLC (0.097g, 42%) as a white solid. Electrospray Mass Spec 407.3 (M+H)+

Example 133

25 N-Hydroxy-2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino)acetamide

To a solution of 5.0g (0.028 mol) of t-butyl sarcosine hydrochloride in 40 mL of chloroform and 7.0 mL of pyridine was added 5.35g (0.028 mol) of 4-fluorobenzenesulfonyl chloride. The reaction was stirred at room temperature for 48h and then concentrated in vacuo. The residue was diluted with ether, washed with water and dried over magnesium sulfate, filtered and concentrated in vacuo. The resulting pale yellow solid was washed with ether/hexanes (1:1) to give 5.7g of [(4-fluoro-

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benzenesulfonyl)-methyl-amino]-acetic acid tert-butylester as a white solid. Electrospray Mass Spec 304.3 (M+H)+

To a solution of 1.820g (6.00 mmol) of [(4-fluoro-benzenesulfonyl)-methyl-amino]-acetic acid tert-butylester in 25 mL of dimethylformamide was added 5.0 mL (4.0g, 72.89 mmol) of propargylamine. The mixture was heated to 80° C and stirred for 48h. The mixture was partitioned between 400 mL of dichloromethane and 200 mL of 20% aqueous NH₄Cl solution. The organic layer was separated, washed with 200 mL of water, dried over anhydrous MgSO₄, filtered, and concentrated in vacuo. Silica gel column chromatography of the residue, eluting with 1% MeOH / CH₂Cl₂, provides 1.067g (53%) of 2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}-amino)acetic acid, tert-butyl ester as a light brown oil. Electrospray Mass Spec 339.3 (M+H)+

To a solution of 0.160g (0.047 mmol) of 2-(methyl{[4-(prop-2-ynylamino)-phenyl]sulfonyl}amino)acetic acid, tert-butyl ester in 1 mL of dichloromethane was added 1 mL of trifluoroacetic acid and the reaction was stirred at room temperature for 19h. Concentration of the mixture in vacuo provides 0.115g (86%) of 2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino)acetic acid as a brown glass. Electrospray Mass Spec 281.1 (M-H)-

According to the procedure of **Example 25**, 0.115g (0.29 mmol) of 2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino)acetic acid provides 0.070g (58%) of N-hydroxy-2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino)-acetamide as an orange foam. Electrospray Mass Spec 298.2 (M+H)+

Example 134

25 2-[(4-But-2-ynylthiophenylsulfonyl)methylamino]-N-hydroxyacetamide

To a solution of 1.820g (6.00 mmol) of the product of [(4-fluoro-benzenesulfonyl)-methyl-amino]-acetic acid tert-butylester in 25 mL of dimethylsulfoxide was added 4.809g (30.00 mmol) of potassium ethyl xanthate. The mixture was heated to 100° C. and stirred for 24h. It was then partitioned between 400 mL of dichloromethane and 400 mL of dilute HCl solution. The organic layer was separated, dried over anhydrous MgSO₄, filtered, and concentrated in vacuo. Silica gel column

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chromatography of the residue, eluting with 1% MeOH / CH₂Cl₂ provided 1.242g (65%) of bis-(4-[[N-(2-acetic acid)-N-methyl]sulfonamido]phenyl)disulfide, bis-tert-butyl ester as a colorless powder. Electrospray Mass Spec 633.2 (M+H)+

To a solution of 0.633g (1.00 mmol) of bis-(4-[[N-(2-acetic acid)-N-methyl]sulfonamido]phenyl)disulfide, bis-tert-butyl ester in a mixture of 3 mL of dioxane and 0.75 mL of water was added a drop of 2N HCl solution and 0.289g (1.10 mmol) of triphenylphosphine. The mixture was stirred 3h at room temperature and the solvents were then removed in vacuo, heating the flask to ensure thorough drying of the residue. It was then dissolved in 4 mL of dimethylformamide and 0.088g (2.20 mmol) of a 60% dispersion of NaH in mineral oil was added. The mixture was stirred 30 min at room temperature and 0.25mL (0.380g, 2.86 mmol) of 1-bromo-2-butyne was added. The mixture was stirred an additional 30 min at room temperature then partitioned between 200 mL of diethyl ether and 200 mL of dilute HCl solution. The organic layer was separated, dried over anhydrous MgSO₄, filtered, and concentrated in vacuo. Silica gel column chromatography of the residue provides 0.588g (80%) of the thioether, 2-[(4-but-2-ynylthiophenylsulfonyl)methylamino]acetic acid tert-butyl ester, as a colorless oil. Electrospray Mass Spec 370.3 (M+H)+

To a solution of 0.313g (1.00 mmol) of 2-[(4-but-2-ynylthiophenylsulfonyl)methylamino]acetic acid tert-butyl ester in 2 mL of dichloromethane was added 2 mL of trifluoroacetic acid. The mixture was stirred at room temperature for 2h and then concentrated in vacuo. Trituration of the residue with diethyl ether provides 0.262g (90%) of the carboxylic acid, 2-[(4-but-2-ynylthiophenylsulfonyl)methylamino]acetic acid, as an off-white solid. Electrospray Mass Spec 312.3 (M-H)-

According to the procedure of **Example 25**, 0.200g (0.638 mmol) of 2-[(4-but-2-ynylthiophenylsulfonyl)methylamino]acetic acid provides 0.147g (70%) of the hydroxamic acid, 2-[(4-but-2-ynylthiophenylsulfonyl)methylamino]-N-hydroxyacetamide, as a colorless solid. Electrospray Mass Spec 329.2 (M+H)+

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Example 135**2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-yl]-2-butynyl]amino}-N-hydroxypropanamide**

According to the procedure for **Example 125**, starting with (2R)-2-(4-but-2-ynyloxy-benzenesulfonylamino)-propionic acid methyl ester (from **Example 107**), the
 5 desired 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-yl]-2-butynyl]amino}-N-hydroxypropanamide was obtained. Electrospray Mass Spec 463.4 (M+H)+

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Example 136**1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxycyclohexanecarboxamide**

To a stirred suspension of methyl-1-amino-1-cyclohexane carboxylate hydrochloride (10 g, 51.7 mmol) and N,N-diisopropylethylamine in methylene chloride
 15 (200 mL) and acetonitrile (50 mL), 4-but-2-ynyloxy-benzenesulfonyl chloride (14.0 g, 56.8 mmol) was slowly added at room temperature. The reaction mixture was stirred for 16 hrs and evaporated to dryness. It was extracted with chloroform, washed well with water and dried over anhydrous MgSO₄. The chloroform layer was filtered and concentrated. The product was crystallized from a mixture acetone:hexane 1:10 to
 20 give methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)cyclohexanecarboxylate as white crystals, 12.5 g.(66%), mp 118-2°C. Electrospray Mass Spec 366 (M+H)⁺.

A mixture of methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)-amino)cyclohexanecarboxylate (4.5g., 12.3 mmol), anhydrous potassium carbonate (20.0 g, excess) and methyl iodide (2g, 14.08 mmol) was refluxed in acetone for sixteen hours. The
 25 reaction mixture was then cooled to room temperature and filtered. The acetone layer was concentrated and extracted with chloroform. The chloroform layer was washed well with water, dried over anhydrous MgSO₄, filtered and concentrated to provide methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino] cyclohexanecarboxylate as a yellow oil. Yield: 4.6 g.(quantitative) Electrospray Mass Spec 380 (M+H)⁺.

30 To a stirred solution of methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)-amino]cyclohexanecarboxylate (4.6 g, 12.1 mmol) in methanol:THF (4:1, 100 ml), 10

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N sodium hydroxide (15 ml) was added at room temperature. The reaction was stirred for 16 h and evaporated to dryness in vacuo and the residue was dissolved in 100 mL water. The pH was adjusted to 1 with 5N hydrochloric acid solution and the mixture was extracted with chloroform, washed with water, dried and concentrated to give 1-
5 [[{4-(2-butynyloxy)phenyl}sulfonyl}(methyl)amino] cyclohexanecarboxylic acid as a yellow solid. Yield: 4 g(88%); mp 124-6 °C Electrospray Mass Spec 364(M-H)⁻.

To a stirred suspension of 1-[[{4-(2-butynyloxy)phenyl}sulfonyl}(methyl)-amino] cyclohexanecarboxylic acid (4.0 gm, 10.9 mmol) in methylene chloride (200 ml)/ DMF (5 ml), oxalyl chloride (8.0 gm, 63 mmol) in methylene chloride (10 ml) was
10 added slowly at 0°C. After the addition, the reaction mixture was stirred at room temperature for 1h. In a separate flask, hydroxylamine hydrochloride (6.9 gm, 100 mmol) was dissolved in DMF/acetonitrile (1:1, 100 ml) and triethylamine (20 gm, 200 mmol) was added. It was stirred at room temperature for 1h and diluted with methylene chloride (50 ml). The acid chloride formed was concentrated to dryness
15 and redissolved in methylene chloride. Hydroxylamine was cooled to 0° C, and the acid chloride was added to the hydroxylamine. The reaction mixture was stirred at room temperature for 6h and concentrated to dryness. It was extracted with chloroform, washed well with water and dried over anhydrous MgSO₄. It was filtered and concentrated. Product was purified by silica-gel column chromatography by
20 eluting it with ethyl acetate: hexane (3:1) to give as a white spongy solid; Yield 3.6g (88%); mp 89-92°C; Electrospray Mass Spec 381 (M+H)⁺; H¹ NMR (CDCl₃) δ: 1.35-1.41 (m, 2H), 1.55-1.72 (m, 6H), 1.80 (s, 3H), 2.23-2.26 (m, 2H), 3.41 (s, 3H), 4.81 (s,2H), 7.22 (dd,2H), 7.89 (dd, 2H), 9.66 (bs, 1H).

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Example 137

1-[[{4-(2-Butynyloxy)phenyl}sulfonyl}(3-pyridinylmethyl)amino] N-hydroxycyclohexanecarboxamide

According to the procedure of Example 136, but using 3-picolyl chloride hydrochloride to alkylate the sulfonamide instead of iodomethane, methyl 1-({4-(2-
30 butynyloxy)phenyl}sulfonyl)amino)cyclohexanecarboxylate was converted into 1-[[{4-(2-butynyloxy)phenyl}sulfonyl}(3-pyridinylmethyl)amino]-N-hydroxycyclohexane-

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carboxamide, obtained as a white solid. mp 179-81⁰ C; Electrospray Mass Spec: 458 (M+H)⁺; ¹H NMR (DMSO) δ : 1.21-1.24 (m, 2H), 1.61-1.72 (m, 6H), 1.81 (s, 3H), 2.48 (m, 2H), 4.59 (s, 2H), 4.72 (s, 2H), 6.91 (m, 1H), 7.20 (dd, 2H), 7.62 (m, 2H), 7.79 (dd, 2H), 7.84 (m, 1H), 12.42-12.58 (bs, 1H).

5

Example 138

1-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxycyclohexanecarboxamide

To a stirred solution of methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino) cyclohexane carboxylate (4.3 g, 11.8 mmol) in methanol : THF (4:1, 100 ml) 10 N sodium hydroxide (15 ml) was added at room temperature. It was stirred for 16 hrs and evaporated to dryness in vacuo. The residue was dissolved in 100 mL water, pH adjusted to 7 with 5N hydrochloric acid solution. It was extracted with chloroform/methanol (3:1), washed with water, dried and concentrated to give 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino) cyclohexane carboxylic acid. Yield 4.0 g (98%); White solid, mp. 112-4⁰C. Electrospray Mass Spec 349 (M-H)⁻.

To a stirred suspension of 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino) cyclohexane carboxylic acid (4.0 gm, 11.4 mmol) in methylene chloride (200 ml)/DMF (5 ml) oxalyl chloride (8.0 gm, 63 mmol) in methylene chloride (10 ml) was added slowly at 0⁰ C. After addition, reaction mixture was stirred at room temperature for 1 hr. In a separate flask, hydroxylamine hydrochloride (6.9 gm, 100 mmol) was dissolved in DMF/acetonitrile (1:1, 100 ml) and triethylamine (20 gm, 200 mmol) was added. It was stirred at room temperature for 1 hr and diluted with methylene chloride (50 ml). The acid chloride formed was concentrated to dryness and redissolved in methylene chloride. Hydroxylamine was cooled to 0⁰ C, and the acid chloride was added to the hydroxylamine. Reaction mixture was stirred at room temperature for 6 hrs and concentrated to dryness. It was extracted with chloroform, washed well with water and dried over anhydrous MgSO₄. It was filtered and concentrated. Product was purified by silica-gel column chromatography by eluting it with ethyl acetate: hexane (3:1) to give 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy cyclohexanecarboxamide. White solid; Yield 3.2 g (78%); M.Pt. 82-84⁰C;

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Electrospray Mass Spec: 367 (M+H)⁺; ¹H NMR (CDCl₃) δ: 1.35-1.41 (m, 2H), 1.55-1.72 (m, 6H), 1.80 (s, 3H), 2.23-2.26 (m, 2H), 4.81 (s, 2H), 5.27 (s, 1H), 7.22 (dd, 2H), 7.89 (dd, 2H), 9.66 (bs, 1H).

5

Example 139**1-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxycyclopentanecarboxamide**

To a stirred suspension of methyl-1-amino-1-cyclopentane carboxylate hydrochloride (15g, 84.0 mmol) and N,N-diisopropylethylamine in methylene chloride (200 mL) and acetonitrile (50 mL), 4-butynyloxyphenylsulfonylchloride (24.7g, 100 mmol) was slowly added at room temperature. Reaction mixture was stirred for 16 hrs and evaporated to dryness. It was extracted with chloroform, washed well with water and dried over anhydrous MgSO₄. Chloroform layer was filtered and concentrated. The product was crystallized from a mixture acetone:hexane (1:1) to give methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)cyclopentane carboxylate as white crystals, 26.8g (91%), mp 81-3°C. Electrospray Mass Spec 352 (M+H)⁺.

To a stirred solution of methyl 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)cyclopentane carboxylate (5.5 g, 15.6 mmol) in methanol:THF (4:1, 100 ml) 10 N sodium hydroxide (15 ml) was added at room temperature. It was stirred for 16h and evaporated to dryness in vacuo, the residue was dissolved in 100 mL water, pH adjusted to 7 with 5N hydrochloric acid solution. It was extracted with chloroform; methanol (3:1) washed with water, dried and concentrated to give 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)cyclopentane carboxylic acid. Yield 4.5 g (86%); White solid, mp. 108-110 °C. Electrospray Mass Spec 336 (M-H)⁻.

To a stirred suspension of 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)cyclopentane carboxylic acid. (1.2 g, 3.56 mmol) in methylene chloride (200 ml)/ DMF (5 ml) oxalyl chloride (8.0 g, 63 mmol) in methylene chloride (10 ml) was added slowly at 0° C. After addition, reaction mixture was stirred at room temperature for 1 hr. In a separate flask, hydroxylamine hydrochloride (6.9 g, 100 mmol) was dissolved in DMF/acetonitrile (1:1, 100 ml) and triethylamine (20 g, 200 mmol) was added. It was stirred at room temperature for 1 hr and diluted with methylene chloride (50 ml).

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The acid chloride formed was concentrated to dryness and redissolved in methylene chloride. Hydroxylamine was cooled to 0° C, and the acid chloride was added to the hydroxylamine. Reaction mixture was stirred at room temperature for 6 hrs and concentrated to dryness. It was extracted with chloroform, washed well with water and dried over anhydrous MgSO₄. It was filtered and concentrated. Product was purified by silica-gel column chromatography by eluting it with ethyl acetate: hexane (3:1) to give 1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy cyclopentane-carboxamide. White solid; Yield 1.1g (88%); mp 66-68°C; Electrospray Mass Spec: 353 (M+H)⁺; ¹H NMR (CDCl₃) δ: 1.32-1.40 (m, 2H), 1.58-1.80 (m, 4H), 1.83 (s, 3H), 1.91-1.94 (m, 1H), 2.03-2.12 (m, 1H), 4.70 (s, 2H), 5.25 (s, 1H), 7.20 (dd, 2H), 7.85 (dd, 2H), 9.58 (bs, 1H).

Example 140

2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino)-N-hydroxy-3 methyl- 3-[(4-morpholinylethyl)sulfanyl]-butanamide hydrochloride

Step 1 A solution of D-penicillamine (0.5g, 3.35mmol) in methanol (5 mL) was cooled to 0°C and crushed sodium hydroxide (0.28g, 6.87mmol) was added to give a clear solution. 2- Bromoethanol (0.26mL, 3.71mmol) was added and stirred at 0°C for 1h and at room temperature for an additional 1.5h. The reaction was concentrated, and the oily residue was dissolved in 3mL water and 6 mL DMF and stirred with sodium carbonate (0.82g 7.2mmol) and 4-butynyloxy-benzenesulfonyl chloride (0.78g, 3.18mmol) at room temperature overnight. The reaction was concentrated and the residue was extracted with ethyl acetate and water. The aqueous layer was acidified to pH ~3 with concentrated HCl and extracted with ethyl acetate. The second ethyl acetate extract was washed with water and brine, dried over sodium sulfate, filtered and concentrated to obtain 1.2g of N-([4-(2 butynyloxy)phenyl]sulfonyl)-3-[(2-hydroxyethyl)sulfanyl]valine as an oil. Yield 89.6%. Electrospray Mass Spec 400.1 (M-H).

Step 2 To a solution of N-([4-(2-butynyloxy)phenyl]sulfonyl)-3-[(2-hydroxyethyl)sulfanyl]valine (1.2g, 2.99mmol) in dimethylacetamide (8mL) was added potassium

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carbonate (3.3g, 23.9mmol), benzyltriethylammonium chloride (0.20g, 0.90mmol) and 2-bromo-2methyl-propane (5.5mL, 47.9mmol) and the mixture was heated at 50°C overnight. The mixture was then diluted with ethyl acetate and washed with water and brine, dried over sodium sulfate, filtered and evaporated to obtain 1.10g of
5 tert-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-3-[(2hydroxyethyl)sulfanyl]-3-methylbutanoate as an oil. Yield ~80.9%. Electrospray Mass Spec 458.2 (M+H)⁺.

Step 3 To a solution of tert-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-3-[(2-sulfonyl)amino)-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoate (1.1g, 2.41mmol)
10 in DMF (8mL) was added iodomethane (0.18mL, 2.89mmol) and potassium carbonate (0.99g, 7.22mmol) and the resulting mixture was stirred at room temperature overnight. After evaporating the solvent, the residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered, and evaporated to obtain 0.96g of tert-butyl 2-([4-(2-
15 butynyloxy)phenyl]sulfonyl)(methyl))amino)-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoate. Yield ~ 85 %. Electrospray Mass Spec 472.2 (M+H)⁺.

Step 4 To a 0° dichloromethane solution (4mL) of tert-butyl 2-([4-(2-butynyloxy)-phenyl]sulfonyl)(methyl)]-amino)-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoate
20 (0.96g, 2.04mmol), carbon tetrabromide (0.68g, 2.04mmol), was added a dichloromethane solution (2mL) of triphenylphosphine and the reaction mixture was stirred at 0°C for 10 minutes and at room temperature overnight. After evaporating the solvent, the oily mixture was purified by column chromatography, eluting with hexane:ethyl acetate (4: 1) to give 0.71g of tert-butyl 2-([4-(2-butynyloxy)phenyl]-
25 sulfonyl)(methyl)]amino)-3-[(2-bromoethyl)sulfanyl]-3 -methylbutanoate.
Yield: 66.4 % . FAB Mass Spec 556 (M+ Na) ⁺.

Step 5 To a solution of tert-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)]-amino)-3-[(2-bromoethyl)sulfanyl]-3-methylbutanoate (0.65g, 1.24mmol) and
30 morpholine (0.27mL, 3.1 mmol) in DMF (6 mL) was added potassium carbonate (0.4g, 2.93 mmol). The mixture was stirred at room temperature overnight. After

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evaporating the solvent, the mixture was extracted with dichloromethane and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated to obtain 0.65g of tert-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)-(methyl)amino)-3-methyl-3-[(2(4-morpholinylethyl)sulfanyl]-butanoate as an oil.

5 Yield: 96%. Electrospray Mass Spec 541.2 (M+ H) ⁺.

Step 6 A solution of tert-butyl 2-{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino)-3-methyl-3-[(2(4-morpholinylethyl)sulfanyl]-butanoate (0.59 g, 1.1mmol) and trifluoroacetic acid (5 mL) in dichloromethane (10 mL) was stirred at room
10 temperature overnight. Evaporating the solvent provide 0.71g of the trifluoroacetic acid salt of N-{[4-2-butynyloxy)phenyl]sulfonyl}-3-{[2-4-morpholinyl)ethyl]-sulfanyl}valine. Electrospray Mass Spec 485.2 (M+ H) ⁺.

Step 7 A solution of N-{[4-2-butynyloxy)phenyl]sulfonyl}-3-{[2-4-morpholinyl)-ethyl]sulfanyl}valine (0.69g, 1.42mmol) in dichloromethane (6mL) and DMF (0.22 mL, 2.85mmol) was cooled in an ice bath and oxalyl chloride (0.71mL of 2M in CH₂Cl₂, 2.85mmol) was dropped in. The reaction mixture was stirred at 0°C for 10 minutes and at room temperature for 2h. The reaction was recooled to 0°, and a THF
15 (4.5mL) solution of triethylamine (0.80mL, 5.70mmol) and hydroxylamine (0.52mL of 50% hydroxylamine in water, 8.55mmol) was added in one portion. The reaction was warmed to room temperature and stirred overnight. After evaporating the solvent, the oily residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered, and evaporated to obtain 0.5g of
20 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino)-N-hydroxy-3-methyl-3-[(2-(4-morpholinylethyl)sulfanyl]-butanamide as a light yellow solid. Yield ~86.2%. mp 45-50°C. Electrospray Mass Spec 500.2 (M+H) ⁺.

The above compound (0.39g, 0.78mmol) was dissolved in dichloromethane (3mL) and cooled in an ice bath. Then a 1M hydrogen chloride solution in ethyl ether (0.86mL, 0.86mmol) was dropped in. The mixture was stirred at 0°C for 10 minutes
30 and at room temperature for 1.5h. The residue was diluted with ethyl ether and filtered

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to give 0.37g of 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-[(2-(4-morpholinylethyl)sulfanyl]-butanamide hydrochloride as a white solid. Mp 50°C (d). Electrospray Mass Spec 500.2 (M+H)⁺.

5

Example 141

**2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-
{[2(4-methyl-1-ethyl-1-piperazinyl)ethyl]sulfanyl}butanamide**

According to the procedure of Example 140, using 1-methylpiperazine in Step 5, 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-
10 { [2(4—methyl-1-ethyl-1-piperazinyl)ethyl]sulfanyl}butanamide was obtained. mp 110-115° C Electrospray Mass Spec 513.3 (M+H)⁺.
Hydrochloride salt mp 90-95° C Electrospray Mass Spec 513.3 (M+H)⁺.

Example 142

15 **2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3 methyl-3-{[2-(diethylamino)ethyl]sulfanyl}butanamide**

According to the procedure of Example 140, using diethylamine in Step 5, 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3methyl-3-{[2-(diethylamino)ethyl]sulfanyl}butanamide was obtained. mp 55-57° C Electrospray
20 Mass Spec 486.4 (M+H)⁺. Hydrochloride salt mp 87-90° C Electrospray Mass Spec 486.5 (M+H)⁺.

Example 143

25 **2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-{[2(1-pyrrolidinyl)ethyl]sulfanyl}butanamide**

According to the procedure of Example 140, using pyrrolidine in Step 5, 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-{[2(1-pyrrolidinyl)ethyl]sulfanyl}butanamide was obtained. mp 55-57° C Electrospray Mass
Spec 484.4(M+H)⁺. Hydrochloride salt mp 58-60° C Electrospray Mass Spec 484.4
30 (M+H)⁺.

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Example 144

**2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-
{[2-(1H-imidazol-1-yl)ethyl]sulfanyl}butanamide**

According to the procedure of Example 140, using imidazole in Step 5, 2-
5 ([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-{[2-(1H-
imidazol-1-yl)ethyl]sulfanyl}butanamide was obtained. mp 97-100° C Electrospray
Mass Spec 481.4 (M+H)⁺. Hydrochloride salt mp 67-70° C Electrospray Mass Spec
481.4 (M+H)⁺.

10

Example 145

**Methyl 1-[2-({2-[([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)]amino}-3-
(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl)ethyl]-2-
pyrrolidinecarboxylate**

According to the procedure of Example 140, using proline ethyl ester in
15 Step 5, methyl 1-[2-({2-[([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)]amino}-3-
(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl)ethyl]-2-pyrrolidine-carboxylate
was obtained. mp 57-60° C Electrospray Mass Spec 542.4 (M+H)⁺.
Hydrochloride salt mp 85-90° C Electrospray Mass Spec 542.5 (M+H)⁺.

20

Example 146

**2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-
[(2-(4-morpholinylpropyl)sulfanyl)]-butanamide**

According to the procedure of Example 140, using 1-bromo-3-propanol in
Step 1, 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-
25 [(2-(4-morpholinylpropyl)sulfanyl)]-butanamide was obtained. mp 48-52° C.
Electrospray Mass Spec 514.4 (M+H)⁺.
Hydrochloride salt mp 94-96° C Electrospray Mass Spec 514.4(M+H)⁺.

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Example 147**2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-{[2(4-methyl-1-ethyl-1-piperazinyl)propyl]sulfanyl}butanamide**

According to the procedure of Example 140, using 1-bromo-3-propanol in
5 Step 1 and 1-methylpiperazine in Step 5, 2-([4-(2-butynyloxy)phenyl]sulfonyl)-
(methylamino)-N-hydroxy-3-methyl-3-{[2(4-methyl-1-ethyl-1-piperazinyl)propyl]-
sulfanyl}butanamide was obtained. mp 58-62° C Electrospray Mass Spec 527.6
(M+H)⁺. Hydrochloride salt mp 74 - 80 ° C Electrospray Mass Spec 527.4 (M+H)⁺.

10

Example 148**2-([4-(2-butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-3-methyl-3-{[2-(diethylamino)propyl]sulfanyl}butanamide**

According to the procedure of Example 140, using 1-bromo-3-propanol in
Step 1 and diethylamine in Step 5, 2-([4-(2-butynyloxy)phenyl]sulfonyl)-
15 (methylamino)-N-hydroxy-3-methyl-3-{[2-(diethylamino)propyl]sulfanyl}butanamide
was obtained. mp 65-68° C Electrospray Mass Spec 500.4 (M+H)⁺.
Hydrochloride salt mp 58-60 ° C Electrospray Mass Spec 500.4 (M+H)⁺.

Example 149**2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-methylsulfanyl-butyramide**

Step 1 A solution of D-penicillamine (0.5g, 3.35mmol) in methanol was cooled to 0°C
and crushed sodium hydroxide (0.28g, 7.04mmol) was added to give a clear solution.
Iodomethane (0.23mL, 3.69mmol) was added and the reaction was stirred at 0°C for
25 10 minutes and at room temperature for an additional 1.5h. After evaporating the
solvent, the residue was dissolved in 2mL of water and acidified with 6N HCl to pH ~
3. After evaporating the solvent again, the oily residue was dissolved in 3mL of water
and 6 mL of DMF and stirred with sodium carbonate (1.17g, 11.0mmol) and 4-but-2-
ynyloxy-benzenesulfonyl chloride (0.9g, 3.69mmol) at room temperature overnight.
30 The solvent was evaporated and the residue was diluted with ethyl acetate and water.

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The aqueous layer was acidified to pH ~3 with concentrated HCl and extracted with ethyl acetate. The second ethyl acetate extract was washed with water and brine, dried over sodium sulfate, filtered and concentrated to provide 0.94g of 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid as a white solid. Yield 75.8%. mp 108-110 °C. Electrospray Mass Spec 369.9 (M-H)⁻.

Step 2 To a solution of 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid (0.37g, 1mmol) dissolved in dimethylacetamide (3mL) was added potassium carbonate (1.12g, 8.1mmol), benzyltriethylammonium chloride (0.073g, 0.32mmol) and 2-bromo-2methyl-propane (1.9mL, 16.4mmol). The mixture was heated to 50°C overnight and then diluted with ethyl acetate and washed with water and brine, dried over sodium sulfate, filtered and evaporated to provide 0.43g of 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid tert-butyl ester as an oil. Yield ~100%. Electrospray Mass Spec 427.9 (M+H)⁺.

Step 3 A solution of 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid tert-butyl ester (0.4g, 0.94mmol) in DMF (5mL) was treated with iodomethane (0.07mL, 1.13mmol) and 0.39g of potassium carbonate at room temperature overnight. After evaporating the solvent, the residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and evaporated to provide 0.33g of 2-[(4-but-2-ynyloxy-benenesulfonyl)-3-methyl-amino]-3-methyl-3-methylsulfanyl-butyric acid tert-butyl ester. Yield ~80.4%. Electrospray Mass Spec 442 (M+H)⁺.

Step 4 To a solution of 2-[(4-but-2-ynyloxy-benenesulfonyl)-3-methyl-amino]-3-methyl-3-methylsulfanyl-butyric acid tert-butyl ester (0.31g, 0.7mmol) in dichloromethane (6mL) was added trifluoroacetic acid (3mL) and the reaction was stirred at room temperature for 1h. The dichloromethane and TFA were evaporated to give the 0.29g of 2-[(4-but-2-ynyloxy-benenesulfonyl)-3-methyl-amino]-3-methyl-3-methylsulfanyl-butyric acid, which was used for next step without further purification. Yield ~100%. Electrospray Mass Spec 383.9(M-H)⁻.

Step 5 A solution of 2-[(4-but-2-ynyloxy-benenesulfonyl)-3-methyl-amino]-3-methyl-3-methylsulfanyl-butyric acid (0.24g, 0.62mmol) in dichloromethane (2mL) was cooled in an ice bath and DMF (0.96 mL, 1.25mmol) was added and followed by oxalyl chloride (0.62mL of a 2M solution in CH₂Cl₂, 1.25mmol). The reaction mixture was stirred at 0°C for 10 minutes and at room temperature for 2h. The reaction was recooled to 0° and a THF (1.5mL) solution of triethylamine (0.35mL 2.49mmol) and hydroxylamine (0.23mL of 50% hydroxylamine in water, 3.74mmol) was added in one portion. The reaction was warmed to room temperature and stirred overnight. After removing solvent, the oily residue was diluted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and evaporated to provide 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-methylsulfanyl-butyramide as a white solid which was triturated with ethyl ether to give 0.23g. Yield ~92%. mp 132-135°C. Electrospray Mass Spec 401 (M+H)⁺.

Example 150

2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butyramide

According to the procedure of **Example 149**, using iodoethane in Step 1 instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butyramide was obtained. mp 130-131°C. Electrospray Mass Spec 425.2 (M+H)⁺.

Example 151

2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide

According to the procedure of **Example 149**, using iodopropane in Step 1 instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide was obtained. mp 132-135°C. Electrospray Mass Spec 429.2 (M+H)⁺.

Example 152**2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-(pyridin-3-ylmethylsulfanyl)-butyramide**

5 According to the procedure of **Example 149**, using 3-picolyl chloride hydrochloride in Step 1 instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-(pyridin-3-ylmethylsulfanyl)-butyramide was obtained. mp 85-88°C . Electrospray Mass Spec 478.1 (M+H)⁺.

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Example 153**2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-benzylsulfanyl-butylamide**

According to the procedure of **Example 149**, using benzyl bromide in Step 1 instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-
15 hydroxy-3-methyl-3-benzylsulfanyl-butylamide was obtained. mp 156-158°C .
Electrospray Mass Spec 477.2 (M+H)⁺.

Example 154**2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(methylsulfanyl)-butylamide**

20

According to the procedure of **Example 149**, using D-cysteine in Step 1 instead of D-penicillamine, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(methylsulfanyl)-butylamide was obtained. Electrospray Mass Spec 373.2 (M+H)⁺.

25

Example 155**2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(pyridin-3-ylmethylsulfanyl)-butylamide**

According to the procedure of **Example 149**, using D-cysteine in Step 1
30 instead of D-penicillamine and 3-picolyl chloride hydrochloride instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-

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(pyridin-3-ylmethylsulfanyl)-butyramide was obtained. mp 90-95°C. Electrospray Mass Spec 450.2 (M+H)⁺.

Example 156

5 **3- (Benzylthio) -2- [[[4-(2-butynyloxy) phenyl] sulfonyl]methylamino] -N-hydroxypropanamide**

According to the procedure of **Example 149**, using D-cysteine in Step 1 instead of D-penicillamine and benzyl bromide instead of iodomethane, 2-[(4-but-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(pyridin-3-ylmethylsulfanyl)-
10 butyramide was obtained. Electrospray Mass Spec 449.2 (M+H)⁺.

Example 157

3- (Benzylthio) -2- [[[4-(2-butynyloxy) phenyl] sulfonyl]pyridin-3-ylmethylamino] -N-hydroxypropanamide

15 According to the procedure of **Example 149**, using D-cysteine in Step 1 instead of D-penicillamine and benzyl bromide instead of iodomethane, and using 3-picolyl chloride hydrochloride instead of iodomethane in Step 3, 3-(benzylthio)-2-[[[4-(2-butynyloxy)phenyl]sulfonyl]pyridin-3-ylmethylamino]-N-hydroxy-propanamide was obtained. mp 74-78°C. Electrospray Mass Spec 526.2 (M+H)⁺.

20

Example 158

2-[[[4-(2-Butynyloxy-phenyl)sulfonyl]amino]-N-hydroxy-3-methyl-(3-methylthio)-butyramide

Step 1 A solution of D-penicillamine (0.5g, 3.35mmol) in methanol was cooled to 0°C
25 and crushed sodium hydroxide (0.28g, 7.04mmol) was added to give a clear solution. Iodomethane (0.23mL, 3.69mmol) was added and the reaction was stirred at 0°C for 10 minutes and at room temperature for an additional 1.5h. After evaporating the solvent, the residue was dissolved in 2mL of water and acidified with 6N HCl to pH ~ 3. After evaporating the solvent again, the oily residue was dissolved in 3mL of water
30 and 6 mL of DMF and stirred with sodium carbonate (1.17g, 11.0mmol) and 4-but-2-

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ynyloxy-benzenesulfonyl chloride (0.9g, 3.69mmol) at room temperature overnight. The solvent was evaporated and the residue was diluted with ethyl acetate and water. The aqueous layer was acidified to pH ~3 with concentrated HCl and extracted with ethyl acetate. The second ethyl acetate extract was washed with water and brine, dried
5 over sodium sulfate, filtered and concentrated to provide 0.94g of 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid as a white solid. Yield 75.8%. mp 108-110 °C. Electrospray Mass Spec 369.9 (M-H)⁻.

Step 2 According to the procedure of Step 5, **Example 149**, 2-(4-but-2-ynyloxy-benenesulfonylamino)-3-methyl-3-methylsulfanyl-butyric acid was converted into the
10 corresponding hydroxamic acid, 2-[[[4-(2-butynyloxy-phenyl)sulfonyl]amino]-N-hydroxy-3-methyl-(3-methylthio)-butyramide. mp 128-132°C. Electrospray Mass Spec 386.9 (M+H)⁺.

15 **Example 159**

2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butyramide

According to the procedure of **Example 158**, using iodoethane instead of iodomethane in Step 1, 2-[(4-but-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-
20 methyl-3-ethylsulfanyl-butyramide was obtained. mp 46-50°C. Electrospray Mass Spec 401.3 (M+H)⁺.

Example 160

25 **2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide**

According to the procedure of **Example 158**, using iodopropane instead of iodomethane in Step 1, 2-[(4-but-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide was obtained. mp 152-155°C. Electrospray Mass
Spec 415.2 (M+H)⁺.

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Example 161**2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-methyl-[(3-pyridinylmethyl)thio]butyramide**

According to the procedure of **Example 158**, using 3-picolyl chloride hydrochloride instead of iodomethane in Step 1, 2-[(4-butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-methyl-[(3-pyridinylmethyl)thio]butyramide was obtained. mp 95-100°C. Electrospray Mass Spec 464.0 (M+H)⁺.

Example 162**2-[(4-Butynyloxy-phenyl)sulfonyl]-amino]-N-hydroxy-3-methyl-(3-benzylsulfanyl)butyramide**

According to the procedure of **Example 158**, using benzyl bromide instead of iodomethane in Step 1, 2-[(4-butynyloxy-phenyl)sulfonyl]-amino]-N-hydroxy-3-methyl-(3-benzylsulfanyl)butyramide was obtained. mp 92-95°C. Electrospray Mass Spec 463.1(M+H)⁺.

Example 163**2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-N-hydroxy-3-[(1-methyl-1H-imidazol-2-yl)methylsulfanyl]butanamide**

According to the procedure of **Example 158**, using 1-methyl-chloromethylimidazole instead of iodomethane in Step 1, 2-([4-(2-butynyloxy)-phenyl]sulfonyl)amino-N-hydroxy-3-[(1-methyl-1H-imidazol-2-yl)methylsulfanyl]-butanamide was obtained. mp 112-115°C. Electrospray Mass Spec 467.1(M+H)⁺.

Example 164**2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-N-hydroxy-3-methyl-3-{[2-(4-morpholinyl)ethyl]sulfanyl}butanamide**

According to the procedure of **Example 158**, using 4-(2-chloro-ethyl)morpholine hydrochloride instead of iodomethane in Step 1, 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-N-hydroxy-3-methyl-3-{[2-(4-morpholinyl)ethyl]-sulfanyl}butanamide was obtained. mp 72°C. Electrospray Mass Spec 486.2 (M+H)⁺.

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Example 165

***tert*-butyl {[2-([4-2-butynyloxy]phenyl)sulfonyl]amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl}acetate**

5 According to the procedure of **Example 158**, using *tert*-butyl bromoacetate instead of iodomethane in Step 1, *tert*-butyl {[2-([4-2-butynyloxy]phenyl)sulfonyl]-amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl}acetate was obtained. mp 47-52°C. Electrospray Mass Spec 487 (M+H)⁺.

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Example 166

***tert*-Butyl {[2-([4-2-butynyloxy]phenyl)sulfonyl]amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl acetic acid, sodium salt**

The product of **Example 165** (0.6g, 1.23mM) was dissolved in trifluoroacetic acid (5mL) and dichloromethane (10mL) and stirred at room temperature overnight. 15 After evaporating the solvent, the residue was purified by preparative TLC, eluting with dichloromethane:methanol (92:8) to obtain 0.23g of *tert*-butyl {[2-([4-2-butynyloxy]phenyl)sulfonyl]amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl]-sulfanyl acetic acid. mp 162-164°C (d). Electrospray Mass Spec 429.3 (M-H)⁻. To this acid (0.22g, 0.51 mmol) in methanol (12mL), was added 1N NaOH (0.52mL, 20 0.52mM) and the reaction was stirred at room temperature for 1h, and then concentrated to provide 0.24g of *tert*-butyl {[2-([4-2-butynyloxy]phenyl)sulfonyl]-amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl}sulfanyl acetic acid, sodium salt as a yellow-orange solid. m.p. 75°C (d). Electrospray Mass Spec 429 (M-H)⁻.

25

Example 167

2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-(methylthio)propanamide

According to the procedure of **Example 158**, using D-cysteine instead of D-penicillamine in Step 1, 2-[(4-butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3- 30 (methylthio)propanamide was obtained. mp 128-130°C. Electrospray Mass Spec 359.2 (M+H)⁺.

Example 168**2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(benzylthio)propanamide**

5 According to the procedure of **Example 158**, using D-cysteine instead of D-penicillamine and benzyl bromide instead of iodomethane in Step 1, 2-[[4-butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(benzylthio)propanamide was obtained. mp 137-138°C. Electrospray Mass Spec 435.1 (M+H)⁺.

10

Example 169**2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(pyridinylthio)propanamide**

According to the procedure of **Example 158**, using D-cysteine instead of D-penicillamine and 3-picolyl chloride hydrochloride instead of iodomethane in Step 1,
15 2-[[4-butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(pyridinylthio)propanamide was obtained. mp 115-120°C. Electrospray Mass Spec 436.1 (M+H)⁺.

Example 170**2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(Z)-11-tetradecenylsulfanyl]propanamide**

20

Cis-11-tetradecen-1-ol (1g, 4.72 mmol) and carbon tetrabromide (1.56g 4.72 mmol) were dissolved in dichloromethane (3ml) and the solution was cooled in ice bath. A solution of triphenylphosphine (1.24g, 4.72 mmol) in 2mL of dichloromethane was added dropwise. After stirring at 0°C for 15 minutes and at
25 room temperature for 3h, the solvent was evaporated and the residue was diluted with ether. The ether solution was filtered and concentrated and purified using column chromatography on silica gel eluting with hexane:ethyl acetate (3:1) to give 0.23g of (Z)-14-bromo-3-tetradecene.

According to the procedure of **Example 158**, using D-cysteine instead of D-
30 penicillamine and (Z)-14-bromo-3-tetradecene instead of iodomethane in Step 1,

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2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(Z)-11-tetradecenyl-sulfanyl]propanamide was obtained. Electrospray Mass Spec 539.5 (M+H)⁺.

Example 171

5 **(2S)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanamide**

Step 1 A solution of 2N sodium hydroxide (11.3 mL, 22.7 mmol) was added to D-(-)-penicillamine (2.5 g, 16.8 mmol) at 0 °C. Once all the solid was dissolved, a solution of 3-bromopropanol (3.03 g, 21.8 mmol) in ethanol (17 mL) was slowly
10 added at 0°C and the resulting mixture was stirred for 15 h at room temperature. The mixture was treated with 1N hydrochloric acid until pH is ~ 6 and the solvents were removed to obtain (2S)-2-amino-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoic acid as a white solid. This solid was used for the next step without further purification; Electrospray Mass Spec 208.1 (M+H)⁺

15 **Step 2** The (2S)-2-amino-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoic acid was dissolved in dioxane:water (1:1) (40 mL). Triethylamine (5.1 mL, 50.4 mmol) was added to the solution followed by 2-butynyloxybenzenesulfonyl chloride (4.1 g, 16.8mmol). The resulting mixture was stirred for 15h at room temperature. The
20 mixture was acidified to pH ~2 with 1N hydrochloric acid and partitioned between ethyl acetate and water. The organic layer was dried over anhydrous sodium sulfate. Removal of the solvent gave 5.78g (83%) of (2S)-2-([4-(2-butynyloxy)phenyl]-sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoic acid as a solid; ¹H-NMR (300 MHz, acetone-d₆) δ 1.34 (s, 3H), 1.39 (s, 3H), 1.66 (m, 2H), 2.06 (m,
25 3H), 2.54-2.68 (m, 2H), 3.89 (m, 1H), 4.82 (m, 2H), 6.56 (d, 1H, J= 9.0 Hz), 7.12(d, 2H, J= 8.7 Hz), 7.81(d, 2H, J= 8.7 Hz). HRMS (C₁₈H₂₅NOS₂)(M+H); calcd. 416.1196, found 416.1199.

Step 3 To a solution of (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoic acid (500 mg, 1.2 mmol) in dimethyl-
30 formamide (10 mL) was added N-hydroxybenzotriazole (194 mg, 1.44 mmol), 1-(3-

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dimethylaminopropyl)-3-ethylcarbodiimide (322 mg, 1.68 mmol) followed by N-methylmorpholine (0.198 mL, 1.8 mmol) and the resulting mixture was stirred for 1 h at room temperature. A 50% aqueous solution of hydroxylamine (0.367 mL, 6 mmol) was added and the mixture was stirred for 15 h at room temperature. The solvent was removed and the product was partitioned between ethyl acetate and water. The organic layer was washed with 1N hydrochloric acid, saturated aqueous sodium bicarbonate solution, brine, and dried over anhydrous sodium sulfate. Removal of the solvent gave (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanamide, which was triturated with hexanes to obtain 130 mg (25%) of the pure product; HRMS ($C_{18}H_{26}N_2O_6S_2$)(M+H); calcd. 431.1305, found 431.1313.

Example 172

(2S)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-propanamide

According to the procedure of Example 171, starting with D-cysteine instead of D-penicillamine, (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-propanamide was obtained. HRMS ($C_{16}H_{22}N_2O_6S_2$)(M + H); calcd. 403.0992, found 403.0991.

Example 173

(3S)-4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-2,2-dimethyl-1,4-thiazepane-3-carboxamide

Step 1 To a solution of (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoic acid from Example 171, (1 g, 2.41 mmol) in dimethylacetamide (6 mL) was added t-butyl bromide (4.16 mL, 36.2 mmol), potassium carbonate (2.66 g, 19.28 mmol), and benzyltriethylammonium chloride (82 mg, 0.36 mmol) and the resulting mixture was heated at 55 °C for 15 h. The solvent was removed and the residue was partitioned with ethylacetate and water. The organic layer was separated, washed with brine and dried over anhydrous sodium sulfate. The solvent was removed to obtain 600 mg (56%) of *tert*-butyl (2S)-2-([4-

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(2-butynyloxy)phenyl]sulfonyl}amino)-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoate; ¹H NMR (300 MHz, CDCl₃) δ 1.22 (s, 9H), 1.35 (s, 3H), 1.39 (s, 3H), 1.76 (m, 2H), 1.80 (m, 3H), 2.41 (m, 1H), 2.68 (m, 2H), 3.71 (m, 3H), 4.69 (m, 2H), 5.74 (d, 1H, J= 9.9 Hz), 7.03 (d, 2H, J= 7.2 Hz), 7.79 (d, 2H, J= 7.2 Hz);
5 HRMS(C₂₂H₃₃NO₆S₂)(M+Na); cald. 494.1641, found 494.1644.

Step 2 To a solution of *tert*-butyl (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanoate (380mg, 0.81 mmol) in tetrahydrofuran (5 mL) was added triphenylphosphine (255 mg, 0.97 mmol) followed by
10 diethylazodicarboxylate (0.14 mL, 0.89 mmol) and the resulting mixture was stirred for 2h at room temperature. The solvent was removed and the crude product was flash chromatographed to obtain 280 mg (62%) of *tert*-butyl (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-1,4-thiazepane-3-carboxylate; ¹H NMR (300 MHz, CDCl₃) 1.29 (s, 9H), 1.37 (s, 3H), 1.61 (s, 3H), 1.85 (m, 3H), 1.91 (m,
15 1H), 2.26 (m, 1H), 2.72 (m, 1H), 2.86 (m, 1H), 3.52 (m, 1H), 4.12 (m, 1H), 4.44 (s, 1H), 4.68 (m, 2H), 7.02 (d, 2H, J= 9.0 Hz), 7.76 (d, 2H, J= 9.0 Hz);
HRMS (C₂₂H₃₁NO₅S₂)(M+); cald. 453.1644, found 452.9784.

Step 3 A solution of *tert*-butyl (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-1,4-thiazepane-3-carboxylate (220 mg, 0.49 mmol) in methylene chloride (4
20 mL) was added trifluoroacetic acid (1.5 mL) and the mixture was stirred for 2h at room temperature. The solvent was removed in vacuo. Traces of trifluoroacetic acid was removed by adding toluene (1 mL) and removing the solvent to obtain 170 mg (88%) of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-1,4-thiazepane-3-
25 carboxylic acid; ¹H NMR (300 MHz, CDCl₃) δ 1.42 (s, 3H), 1.60 (s, 3H), 1.85 (m, 3H), 1.91 (m, 1H), 2.17 (m, 1H), 2.67 (m, 1H), 2.82 (m, 1H), 3.54 (m, 1H), 3.82 (m, 1H), 4.59 (s, 1H), 4.68 (m, 2H), 7.0 (d, 2H, J= 8.7 Hz), 7.75 (d, 2H, J= 8.7 Hz);
HRMS (C₁₈H₂₃NO₅S₂)(M+); cald. 397.1018, found 397.0998.

30 **Step 4** Following the procedure of Step 3, **Example 171**, (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-1,4-thiazepane-3-carboxylic acid (140 mg,

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0.35 mmol), N-hydroxybenzotriazole (57 mg, 0.42 mmol), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide (94 mg, 0.49 mmol), N-methylmorpholine (0.058 mL, 0.53 mmol), and aqueous hydroxylamine (0.107 mL, 1.75 mmol) in dimethylformamide (3 mL) provided 80 mg (56%) of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-2,2-dimethyl-1,4-thiazepane-3-carboxamide; ¹H NMR(300 MHz, DMSO-d₆) δ 1.26 (s, 3H), 1.56 (s, 3H), 1.87 (m, 1H), 1.91 (m, 3H), 2.06 (m, 1H), 2.73 (m, 2H), 3.20 (m, 1H), 4.21 (s, 1H), 4.80 (m, 1H), 4.90 (m, 2H), 7.16 (d, 2H, J= 9.0 Hz), 7.79 (d, 2H, J= 9.0 Hz); HRMS (C₁₈H₂₄N₂O₅S₂)(M+Na); cald. 413.1199, found 413.1205.

10

Example 174

(3S)-4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide

Starting with D-cysteine, following the procedure of Steps 1 and 2 of **Example 171**, (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)-sulfanyl]-3-propanoic acid was obtained.

According to the procedure of Step 1 of **Example 173**, the acid (2 g, 5.17 mmol) was converted into the corresponding t-butyl ester using t-butylbromide (8.9 mL, 77.5 mmol), potassium carbonate (5.7 g, 41.4 mmol), and benzyltriethylammonium chloride (177 mg, 0.77 mmol) in dimethylacetamide (12 mL) to obtain 1.5 g (66%) of tert-butyl (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-propanoate; ¹H NMR (300 MHz, CDCl₃) δ 1.32 (s, 9H), 1.82 (m, 1H), 1.85 (m, 3H), 1.93 (br s, 1H), 2.71 (t, 2H, J= 6.9 Hz), 2.85 (m, 2H), 3.74 (m, 2H), 4.02 (m, 1H), 4.72 (m, 2H), 5.58 (d, 1H, J= 8.4 Hz), 7.04 (d, 2H, J= 8.7 Hz), 7.81 (d, 2H, J= 8.7 Hz); Electrospray Mass Spec 444.1 (M+H)+;

25

Following the procedure for Step 2 of **Example 173**, tert-butyl (2S)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-[(3-hydroxypropyl)sulfanyl]-3-propanoate (1.4 g, 3.16 mmol), triphenylphosphine (993 mg, 3.79 mmol), and diethylazodicarboxylate (0.547 mL, 3.48 mmol) in tetrahydrofuran (20 mL) provided 1.1 g (82%) of tert-butyl (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-1,4-thiazepane-3-carboxylate;

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¹H NMR (300 MHz, CDCl₃) 1.31 (s, 9H), 1.85 (m, 3H), 1.93 (m, 1H), 2.04 (m, 1H), 2.65 (m, 1H), 2.76 (m, 1H), 2.88 (m, 1H), 3.15 (m, 1H), 3.31 (m, 1H), 3.80 (m, 1H), 4.70 (m, 3H), 7.03 (d, 2H, J= 8.7 Hz), 7.77 (d, 2H, J= 8.7 Hz);

HRMS (C₂₀H₂₇NO₅S₂)(M + H); calcd. 426.1403, found 426.1404.

5 Following the procedure of Step 3 of **Example 173**, *tert*-butyl (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-1,4-thiazepane-3-carboxylate (800 mg, 1.88 mmol), trifluoroacetic acid (6 mL) in methylene chloride (15 mL) provide 650 mg (94%) of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-1,4-thiazepane-3-carboxylic acid; ¹H NMR (300 MHz, acetone-d₆): δ 1.74 (m, 3H), 1.90 (m, 2H), 2.59 (m, 2H), 2.90 (m,
10 1H), 3.18 (m, 1H), 3.26 (m, 1H), 3.70 (m, 1H), 4.70 (m, 3H), 7.03 (d, 2H, J= 8.7 Hz), 7.77 (d, 2H, J= 8.7 Hz); HRMS (C₁₆H₁₉NO₅S₂)(M+H); calcd. 370.0777, found 370.0765.

Following the procedure Step 3 of **Example 171**, (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-1,4-thiazepane-3-carboxylic acid (400 mg, 1.08 mmol),
15 N-hydroxybenzotriazole (175 mg, 1.29 mmol), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (290 mg, 1.51 mmol), N-methylmorpholine (200 μL, 1.62 mmol), and 50% aqueous hydroxylamine (331 mL, 5.4 mmol) provided 200 mg (48%) of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide; HRMS (C₁₆H₂₀N₂O₅S₂)(M+H); calcd. 385.0886, found 385.0886.

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Example 175

(3S)-4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide 1,1-dioxide

To a cooled (0 °C) solution of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-1,4-thiazepane-3-carboxamide (80 mg, 0.21 mmol) in chloroform (2 mL) was
25 added 32% peracetic acid (0.132 mL, 0.63 mmol) and the reaction mixture was stirred overnight at room temperature. The solvent was removed and the residue was dissolved in ethyl acetate and dried over anhydrous sodium sulfate. Removal of the solvent gave 60 mg (69%) of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-
30 1,4-thiazepane-3-carboxamide 1,1-dioxide; ¹H NMR (300 MHz, DMSO-d₆) δ 1.80 (br

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s, 2H), 1.84 (m, 3H), 3.07-3.80 (m, 5H), 4.00 (m, 1H), 4.53 (m, 1H), 4.84 (m, 2H), 7.03 (d, 2H, J= 8.7 Hz), 7.77 (d, 2H, J= 8.7 Hz), 9.05 (s, 1H), 10.32 (s, 1H); MS (ES)(M + H)⁺; 416.9.

5

Example 176**2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-(4-hydroxyphenyl)acetamide**

To a solution of 167.2 mg (1.00 mmol) of D-4-hydroxyphenyl glycine in 3.7 ml of CH₃CN was added 0.56 ml (2.09 mmol) of bis(trimethylsilyl)trifluoroacetamide, and the reaction mixture was gently refluxed for 2h. The resulting clear solution was cooled to 40 °C, and 0.096 ml (1.2 mmol) pyridine and 269.2 mg (1.099 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride were added. The reaction mixture was heated at 70 °C for 3h and stirred at room temperature for 14h. The solvent was evaporated and the resulting oily residue was treated with 15% NaHSO₄ and stirred for 1h. The mixture was extracted with ethyl acetate. The combined organics were then dried over MgSO₄, filtered and concentrated in vacuo. The crude material was triturated in hexane to get 319 mg (85%) of ([4-(2-butynyloxy)phenyl]-sulfonyl)-amino)(4-hydroxyphenyl)acetic acid as a pale yellow solid. Electrospray Mass Spec 374.3 (M-H)⁻

To a solution of 12.18 g (32.48 mmol) of product of ([4-(2-butynyloxy)phenyl]sulfonyl)amino)(4-hydroxyphenyl)acetic acid in 5 ml of DMF at room temperature was added 165.65 g (1.95 mol) of NaHCO₃, 17.4 g (90.9 mmol) of EDC, 10.53g (77.95 mmol) of HOBT and 61.2 g (487.2 mmol) of O-*t*-butylhydroxylamine hydrochloride. The reaction was stirred at 50°C for 6h, then at room temperature overnight. DMF was removed. The resulting light brown solid was diluted with ethyl acetate/water, extracted with ethyl acetate, washed with brine, dried over MgSO₄, filtered, and concentrated in vacuo. The crude material was washed with 3-5 ml dichloromethane, The product, N-(tert-butoxy)-2-([4-(2-butynyloxy)phenyl]-sulfonyl)amino)-2-(4-hydroxyphenyl)acetamide, (12 g, 83%) was obtained as a light yellow solid. Electrospray Mass Spec 447.4 (M+H)⁺

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A 450 mg (1.007 mmol) portion of N-(tert-butoxy)-2-([4-(2-butynyloxy)-phenyl]sulfonyl)amino)-2-(4-hydroxyphenyl)acetamide was stirred in neat TFA at room temperature for 72 h. TFA was removed in vacuo. The residue was chromatographed on preparative TLC, eluting with 1% HOAc and 10% MeOH in dichloromethane to provide 33.8 mg (9%) of 2-([4-(2-butynyloxy)phenyl]sulfonyl)-amino)-N-hydroxy-2-(4-hydroxyphenyl)acetamide as a white solid. Electrospray Mass Spec 391.4 (M+H)⁺

Example 177

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-[4-(2-propynyloxy)phenyl]acetamide

To a solution of 321.6 mg (0.72 mmol) of N-(tert-butoxy)-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-2-(4-hydroxyphenyl)acetamide from **Example 176** in 3 ml DMF at 0 °C was added 199 mg (1.44 mmol) of K₂CO₃. The reaction mixture was stirred for 15 min, 94.4 mg (0.79 mmol) of propargyl bromide was added, and reaction mixture was stirred at room temperature overnight. DMF was removed in vacuo. The residue was diluted with ethyl acetate, washed with 1N HCl solution, water and brine. The organic layer was dried over MgSO₄, filtered, and concentrated in vacuo. The crude material was chromatographed on silica gel, eluting with hexane / ethyl acetate (5:1, 4:1 then 3:1) to provide 75 mg (17%) of N-(tert-butoxy)-2-([4-(2-butynyloxy)-phenyl]sulfonyl)amino)-2-[4-(2-propynyloxy)phenyl]acetamide as a white solid. Electrospray Mass Spec 485.4 (M+H)⁺

The 75 mg (0.154 mmol) sample of N-(tert-butoxy)-2-([4-(2-butynyloxy)-phenyl]sulfonyl)amino)-2-[4-(2-propynyloxy)phenyl]acetamide was stirred in neat TFA at room temperature for 72 h. TFA was removed in vacuo. The residue was chromatographed on prep. TLC eluting with 1% HOAc in 10% MeOH/ CH₂Cl₂ to provide 11.1 mg (17%) of 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-[4-(2-propynyloxy)phenyl]acetamide as a white solid was obtained. High Resolution Mass Spec 429.11155 (M+H)⁺; Calc'd for C₂₁H₂₁N₂O₆S 429.11149.

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Example 178**2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy -2-(4-methoxyphenyl)acetamide**

To 50 mL of methanol cooled to 0°C was dropwise added 3.75 mL of thionyl chloride followed by 5.0g (0.030 mmol) of D-4-hydroxyphenylglycine. The reaction was heated to reflux for 5h then stirred overnight at room temperature. The resulting mixture was concentrated in vacuo and the residue was diluted with ether. The resulting solid was collected by filtration and dried in vacuo to provide 5.9g of amino-(4-hydroxy-phenyl)-acetic acid methyl ester as a white solid. Electrospray Mass Spec
182.2 (M+H)⁺

To a solution of 5.0g (0.023 mmol) of amino-(4-hydroxy-phenyl)-acetic acid methyl ester dissolved in 30 mL of chloroform was added 30 mL of pyridine followed by 5.85g (0.023 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride. The reaction was stirred overnight at room temperature and then diluted with ethyl acetate. The organics were washed with 5% HCl solution and water, dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide [[4-(2-butynyloxy)phenyl]sulfonyl]amino](4-hydroxyphenyl)acetate as pale yellow crystals.

To a solution of 0.350g (0.900 mmol) of [[4-(2-butynyloxy)phenyl]sulfonyl]amino](4-hydroxyphenyl)acetate dissolved in 3 mL of DMF was added 0.079g (1.979 mmol) of a 60% oil dispersion of sodium hydride. The reaction was stirred for 30min at room temperature and then 0.224 mL of iodomethane was added. After 5h the reaction was diluted with water and extracted with ether. The combined organics were washed with water, dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide [[4-(2-butynyloxy)phenyl]sulfonyl](methyl)-amino](4-methoxyphenyl)acetate as a white waxy solid. Electrospray Mass Spec 418.1 (M+H)⁺

According to the procedures of Examples 11 and 9 [[4-(2-butynyloxy)-phenyl]sulfonyl](methyl)amino](4-methoxyphenyl)acetate was hydrolyzed to the carboxylic acid and then converted into the hydroxamic acid, 2-[[4-(2-butynyloxy)-

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phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-(4-methoxyphenyl)-acetamide.

Electrospray Mass Spec 419.3 (M+H)⁺

Example 179

5 **2-[[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide**

To a solution of 6.62g (0.017 mmol) of [[4-(2-butynyloxy)phenyl]-sulfonyl]-amino](4-hydroxyphenyl)acetate from **Example 178** in 50 mL of DMF was added 3.08g (0.020 mmol) of tert-butyldimethylsilyl chloride followed by 2.89g (0.043
10 mmol) of imidazole. The reaction was stirred at room temperature for 5h and then diluted with ether. The resulting mixture was washed with water, dried over magnesium sulfate, filtered and concentrated in vacuo to give 7.06g of [4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-(4-but-2-ynyloxy-benzenesulfonylamino)-acetic acid methyl ester as a white solid. Electrospray Mass Spec 504.4 (M+H)⁺

15 To a solution of 7.06g (0.014 mmol) of [4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-(4-but-2-ynyloxy-benzenesulfonylamino)-acetic acid methyl ester dissolved in 50 mL of DMF was added 0.618g (0.015 mmol) of a 60% oil dispersion of sodium hydride. The reaction was stirred for 30min at room temperature and then 2.62 mL of iodomethane was added. After 5h the reaction was diluted with water and extracted
20 with ether. The combined organics were washed with water, dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide [4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-acetic acid methyl ester as a white waxy solid. Electrospray Mass Spec 518.4 (M+H)⁺

25 To a solution of 6.0g (0.012 mmol) of [4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-[(4-but-2-ynyloxy-benzenesulfonyl)-methyl-amino]-acetic acid methyl ester in 100 mL of THF was added 11.6 mL of a 1.0M solution of tetrabutylammonium fluoride in THF. The reaction was stirred for 1h at room temperature and then acidified with 5% HCl solution and extracted with ethyl acetate. The organics were
30 dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to give 2.7g of

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methyl [{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-hydroxyphenyl)acetate as a white solid. . Electrospray Mass Spec 404.2 (M+H)⁺

To a solution of 0.25g (0.620 mmol) of methyl [{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-hydroxyphenyl)acetate in 10 mL of acetone was added
 5 0.342g of potassium carbonate, 0.231g (1.241 mmol) of 4-(2-chloroethyl)morpholine hydrochloride and 1 equivalent of sodium iodide. The reaction was heated to reflux for 5h, diluted with water and extracted with chloroform. The organics were dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with chloroform/methanol (9:1) to provide 0.156g of methyl 2-
 10 [{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-{4-[2-(4-morpholinyl)ethoxy]-phenyl}acetate.

According to the procedures of **Examples 11** and **9** methyl 2-{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-{4-[2-(4-morpholinyl)ethoxy]-phenyl}acetate was hydrolyzed to the carboxylic acid and then converted into the hydroxamic acid,
 15 2-{{[4-(2-butynyloxy)phenyl]-sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide. Electrospray Mass Spec 518.3 (M+H)⁺

Example 180

***tert*-Butyl 2-{4-[1-{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate**

To a solution of 0.488g (1.861 mmol) of triphenylphosphine in 10 mL of THF was added 0.287g (1.861 mmol) of *tert*-butyl *N*-(2-hydroxyethyl)-carbamate followed by 0.500g (1.241 mmol) of methyl [{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-hydroxyphenyl)acetate (from **Example 179**) and 0.293 mL (1.861 mmol) of diethyl azodicarboxylate. The reaction was stirred overnight at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.677g of methyl (4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl)[{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-acetate as a white solid. Electrospray Mass Spec 547.4 (M+H)⁺

According to the procedures of **Examples 11** and **25** methyl (4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl)[{{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)-

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amino]acetate was hydrolyzed to the carboxylic acid and then converted into the hydroxamic acid, *tert*-butyl 2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)-amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate. Electrospray Mass Spec 548.5 (M+H)⁺

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Example 181

2-[4-(2-Aminoethoxy)phenyl]-2-[[4-(2-

butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxyacetamide

To a solution of 0.156 g(0.285 mmol) of *tert*-butyl 2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy-ethylcarbamate from **Example 180** dissolved in 2 mL of dichloromethane was added 3.0 mL of a 1.0M solution of HCl in ether. The reaction was stirred at room temperature for 3h and then diluted with ether. The resulting solid was collected by filtration and dried in vacuo to give 0.099g of the hydrochloride salt of 2-[4-(2-amino-ethoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-acetamide as a tan solid. Electrospray Mass Spec 448.3 (M+H)⁺

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Example 182

2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-2-{4-[2-(dimethylamino)ethoxy]phenyl}-N-hydroxyacetamide

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To a solution of 0.390g (1.489 mmol) of triphenylphosphine in 8 mL of THF was added 0.150 mL (1.489 mmol) of *N,N*-dimethylethanolamine followed by 0.400g (0.993 mmol) of methyl [[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino](4-hydroxyphenyl)acetate (from **Example 179**) and 0.234 mL (1.489 mmol) of diethyl azodicarboxylate. The reaction was stirred overnight at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.246g of methyl[[4-(2-butynyloxy)phenyl]-sulfonyl](methyl)amino]{4-[2-(dimethylamino)ethoxy]phenyl}acetate as a white solid. Electrospray Mass Spec 475.2 (M+H)⁺

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According to the procedures of **Examples 11 and 9** methyl[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]{4-[2-(dimethylamino)ethoxy]phenyl}acetate was

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hydrolyzed to the carboxylic acid and then converted into the hydroxamic acid, 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-{4-[2-(dimethylamino)-ethoxy]-phenyl}-N-hydroxyacetamide. Electrospray Mass Spec 476.4 (M+H)⁺

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Example 183

2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide

According to the procedure of **Example 182**, using 1-(2-hydroxyethyl)-pyrrolidine instead of *N,N*-dimethylethanolamine, 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)-ethoxy]phenyl}acetamide
10 was obtained as a tan solid. Electrospray Mass Spec 502.2 (M+H)⁺

Example 184

2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(2-oxo-1-pyrrolidinyl)ethoxy]phenyl}acetamide
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According to the procedure of **Example 180**, using 1-(2-hydroxyethyl)-2-pyrrolidinone instead of *tert*-butyl *N*-(2-hydroxyethyl)-carbamate, 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(2-oxo-1-pyrrolidinyl)-ethoxy]phenyl}acetamide was obtained as a white foam. Electrospray Mass Spec
20 516.2 (M+H)⁺

Example 185

***tert*-butyl 4-(2-{4-[1-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-1-piperazinecarboxylate**

According to the procedure of **Example 180**, using *tert*-butyl *N*-(2-hydroxyethyl)piperazine carbamate instead of *tert*-butyl *N*-(2-hydroxyethyl)-carbamate, *tert*-butyl 4-(2-{4-[1-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-1-piperazinecarboxylate was obtained as a white
25 solid. Electrospray Mass Spec 617.4 (M+H)⁺

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Example 186**2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(1-piperazinyl)ethoxy]phenyl}acetamide**

To a solution of 0.300g (0.487 mmol) of *tert*-butyl 4-(2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}-ethyl)-1-piperazinecarboxylate (from **Example 185**) in 1 mL of dichloromethane was added 1 mL of trifluoroacetic acid. The reaction was stirred at room temperature for 3h and then concentrated in vacuo. The residue was diluted with chloroform/methanol(9:1) and washed with saturated sodium bicarbonate solution. The organics were dried over sodium sulfate, filtered and concentrated in vacuo. The residue was diluted with 2 mL of dichloromethane and 0.25 mL of methanol and 1 mL of a 1.0M solution of HCl in ether was added. After 30 minutes the mixture was concentrated in vacuo to provide 0.189g of the hydrochloride salt of 2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-{4-[2-(1-piperazinyl)ethoxy]phenyl}acetamide as a tan solid. Electrospray Mass Spec 517.3 (M+H)⁺

Example 187***tert*-Butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate**

According to the procedure of **Example 180**, Mitsunobu reaction of *tert*-butyl *N*-(3-hydroxypropyl)carbamate and methyl [[4-(2-butynyloxy)-phenyl]sulfonyl-(methyl)amino](4-hydroxyphenyl)acetate provides methyl (4-{3-[(*tert*-butoxycarbonyl)amino]propoxy}phenyl)[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)-amino]-acetate.

According to the procedures of **Examples 11** and **25** this methyl ester was converted into the hydroxamic acid *tert*-butyl 3-{4-[1-[[4-(2-butynyloxy)-phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}-propylcarbamate, obtained as a white foam. Electrospray Mass Spec 560.2 (M-H)⁻

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Example 188**2-[4-(3-Aminopropoxy)phenyl]-2-[[4-(2-****butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxyacetamide**

Hydrogen chloride gas was bubbled through a solution of 0.371g (0.661 mmol) of *tert*-butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-(hydroxy-amino)-2-oxoethyl]phenoxy}propylcarbamate (from **Example 187**) dissolved in 5 mL of dichloromethane for 5 minutes. The reaction was stoppered and let sit at room temperature for 1h and then the solvent was evaporated. The residue was triturated with ether, filtered and dried in vacuo to give 0.314g of 2-[4-(3-aminopropoxy)-phenyl]-2-[[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxyacetamide as a white solid. Electrospray Mass Spec 462.2 (M+H)⁺

Example 189

***tert*-Butyl (3S)-3-{4-[(1R)-1-[[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}-1-pyrrolidinecarboxylate**

According to the procedure of **Example 180**, using *tert*-butyl *N*-(3-pyrrolidinol)carbamate instead of *tert*-butyl *N*-(2-hydroxyethyl)-carbamate, *tert*-butyl (3S)-3-{4-[(1R)-1-[[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-(hydroxy-amino)-2-oxoethyl]phenoxy}-1-pyrrolidinecarboxylate was obtained as a white solid. Electrospray Mass Spec 574.1 (M+H)⁺

Example 190

(2R)-2-[[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[(3S)-pyrrolidinyl]phenyl}ethanamide

According to the procedure of **Example 188**, 0.20g (0.349 mmol) of *tert*-butyl (3S)-3-{4-[(1R)-1-[[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-(hydroxy amino)-2-oxoethyl]phenoxy}-1-pyrrolidinecarboxylate (the product of **Example 189**) was converted into 0.157g of (2R)-2-[[4-(2-butynyloxy)phenyl]-sulfonyl}-(methyl)-amino]-N-hydroxy-2-{4-[(3S)-pyrrolidinyl]phenyl}ethanamide hydrochloride, obtained as a tan glass. Electrospray Mass Spec 474.1 (M+H)⁺

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Example 191

***tert*-Butyl (2-{4-1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino)-2-(hydroxyamino)-2-oxoethyl}phenoxy]ethyl)-(methyl)carbamate**

According to the procedure of **Example 182**, starting with the *t*-butyl carbamate of 2-(methylamino)ethanol, *tert*-butyl (2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino)-2-(hydroxyamino)-2-oxoethyl}phenoxy]ethyl)-(methyl)carbamate was obtained. mp 62°C (d). Electrospray Mass Spec 562.3 (M+H)⁺

Example 192

2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide

According to the procedure of **Example 181**, *tert*-butyl (2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino)-2-(hydroxyamino)-2-oxoethyl}phenoxy]ethyl)-(methyl)carbamate from **Example 191** was converted into the hydrochloride salt of 2-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide. mp 165°C(d). Electrospray Mass Spec 462.4 (M+H)⁺.

Example 193

Ethyl 3-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino]-2-(hydroxyamino)-2-oxoethyl}phenoxy}propylcarbamate

Step 1 Through a solution of 7.0g (12.8 mmol) of methyl (4-{3-[(*tert*-butoxycarbonyl)amino]propoxy}phenyl)[{4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino]acetate (from **Example 187**) dissolved in dichloromethane was bubbled hydrogen chloride gas for 1.5h. The reaction was stoppered and let sit at room temperature for 30 minutes. The reaction was then poured into water, neutralized with 1N sodium hydroxide solution to pH~8 and extracted with dichloromethane. The organics were washed with water and brine, dried over sodium sulfate, filtered and concentrated to give 5.41g of methyl [4-3-(3-aminopropoxy)phenyl][{4-(2-butynyloxy)phenyl]sulfonyl)methyl)amino]acetate. Electrospray Mass Spec 461.1 (M+H)⁺.

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- Step 2** To a solution of methyl [4-3-(3-aminopropoxy)phenyl][{[4-(2-butynyloxy)-phenyl]sulfonyl}methyl)amino]acetate (0.5g, 1.1 mmol) and N,N- diisopropylethyl amine (0.95 mL, 5.4mmol) in dichloromethane, cooled in an ice bath was dropwise added a dichloromethane (1ml) solution of ethyl chloroformate (0.178ml, 1.1mmol).
- 5 The reaction was stirred at 0°C for 10 minutes and at room temperature for 2h. The reaction was diluted with dichloromethane, washed with water and brine, dried over sodium sulfate, filtered, and concentrated. The residue was separated using column chromatography on silica gel eluting with dichloromethane:methanol (100:2) to give 0.5g of methyl [{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-{3-[(ethoxycarbonyl)amino]propoxy]phenyl)acetate. Yield 76.3%. Electrospray Mass Spec 533.1 (M+H)⁺.
- 10

- Step 3** A mixture of methyl [{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-{3-[(ethoxycarbonyl)amino]propoxy]phenyl)acetate (0.45g, 0.85 mmol) and 1N NaOH (4.2ml, 4.23 mmol) in THF (5ml) and methanol (5 ml) was stirred at room temperature for 2h. After removing the solvent, the residue was dissolved in water, neutralized with HCl to pH~ 5-6 and extracted with dichloromethane. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated to provide 0.36g of [{[4-(2-butynyloxy)phenyl]-sulfonyl}(methyl)-amino}(4-{3-[(ethoxycarbonyl)amino]propoxy]phenyl)acetic acid as a solid. Yield 81.8 %. Electrospray Mass Spec 519.1 (M+H)⁺.
- 15
- 20

- Step 4** To [{[4-(2-butynyloxy)phenyl]sulfonyl}(methyl)amino}(4-{3-[(ethoxycarbonyl)amino]propoxy]phenyl)acetic acid (0.35g, 0.67mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide (0.2g, 1.01mmol) in DMF (8ml), 1-hydroxybenzotriazole (0.13g, 0.95mmol) was added and the reaction was stirred at room temperature for 2h. Hydroxylamine (0.23ml of 50 % in water , 3.71mmol) was added and the reaction was stirred overnight. After evaporating the solvent, the residue was extracted with ethyl acetate and water, the organic layer was washed with saturated NaHCO₃, water and brine, dried over Na₂SO₄, and concentrated. The residue was purified with preparative TLC plates (eluting with ethyl acetate:methanol (85:15) to
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- 30

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provide 0.1g of ethyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate as a yellow solid. mp 60-62°C. Electrospray Mass Spec 532 (M+H)⁺.

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Example 194

2-{4-[3-(Acetylamino)propoxy]phenyl}-2-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-N-hydroxyacetamide

According to the procedure of **Example 193**, using acetyl chloride instead of ethyl chloroformate in Step 2, 2-{4-[3-(acetylamino)propoxy]phenyl}-2-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-N-hydroxyacetamide was obtained. mp 88°C (d). Electrospray Mass Spec 504 (M+H)⁺.

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Example 195

Butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate

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According to the procedure of **Example 193**, using n-butyl chloroformate instead of ethyl chloroformate in Step 2, butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}-propylcarbamate was obtained. mp 50-55°C. Electrospray Mass Spec 562 (M+H)⁺.

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Example 196

Benzyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate

According to the procedure of **Example 193**, using benzyl chloroformate instead of ethyl chloroformate in Step 2, benzyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate was obtained. mp 48-50°C. Electrospray Mass Spec 596.4 (M+H)⁺.

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Example 197**2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-(4-{3-[(methylsulfonyl)amino]propoxy}phenyl)acetamide**

According to the procedure of **Example 193**, using methanesulfonyl chloride instead of ethyl chloroformate in Step 2, 2-[[4-(2-butynyloxy)phenyl]-sulfonyl]-(methylamino)-N-hydroxy-2-(4-{3-[(methylsulfonyl)amino]propoxy}-phenyl)-acetamide was obtained. mp 65-70°C. Electrospray Mass Spec 540.4 (M+H)⁺.

Example 198

10 **2-(4-{3-[(Anilincarbonyl)amino]propoxy}phenyl)-2-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxyacetamide**

According to the procedure of **Example 193**, using phenyl isocyanate instead of ethyl chloroformate in Step 2, 2-(4-{3-[(anilincarbonyl)amino]propoxy}phenyl)-2-[[4-(2-butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxyacetamide was
15 obtained. mp 135°C (d). Electrospray Mass Spec 581 (M+H)⁺.

Example 199

***tert*-Butyl 2-{4-[(1R)-1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate**

20 **Step 1** To a 0° solution of 2.50g (11.48 mmol) of amino-(4-hydroxy-phenyl)-acetic acid methyl ester (from **Example 178**) in 125 mL of dichloromethane was added 10 mL of *N,N*-diisopropylethylamine followed by 2.97g (11.48 mmol) of 9-fluorenyl-methyl chloroformate and the resulting mixture was stirred at 0° for 2h and room temperature for 2h. The reaction mixture was then concentrated and the residue was
25 diluted with ethyl acetate and water. The organics were washed with water, dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide methyl(2R)-{[(9H-fluoren-9-ylmethoxy)carbonyl]amino}(4-hydroxyphenyl)ethanoate as a white solid. Electrospray Mass Spec 404.1 (M+H)⁺.

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Step 2 To a solution of 0.465g (1.77 mmol) of triphenylphosphine in 10 mL of THF was added 0.286g (1.77 mmol) of *tert*-butyl *N*-(2-hydroxyethyl)-carbamate followed by 0.476g (1.18 mmol) of methyl (2R)-{[(9H-fluoren-9-ylmethoxy)carbonyl]-amino}-(4-hydroxyphenyl)ethanoate and 0.279 mL (1.77 mmol) of diethyl azodicarboxylate.

- 5 The reaction was stirred overnight at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.383g of methyl (2R)-(4-{2-[(*tert*-butoxycarbonyl)-amino]ethoxy}phenyl){[(9H-fluoren-9-ylmethoxy)carbonyl]-amino}ethanoate as a white solid. Electrospray Mass Spec 547.2 (M+H)⁺

10

- Step 3** A solution of 1.695g (3.10 mmol) of methyl (2R)-(4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl){[(9H-fluoren-9-ylmethoxy)carbonyl]amino}-ethanoate in 10 mL of diethylamine was stirred at room temperature for 2h and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with a gradient starting with ethyl acetate/hexanes (1:2) and ending with chloroform/methanol (9:1) to provide 0.717g of methyl (2R)-amino(4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl)ethanoate as a colorless oil. Electrospray Mass Spec 325.2 (M+H)⁺

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- Step 4** To a solution of 0.682g (2.10 mmol) of methyl (2R)-amino(4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl)ethanoate dissolved in 10 mL of chloroform and 2.2mL of pyridine was added 0.566g (2.315 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride. The reaction was stirred at room temperature for 15h and then diluted with ether. The organics were washed with water, 5% HCl solution and brine, dried over magnesium sulfate, filtered and concentrated in vacuo to provide
- 20 0.691g of methyl (2R)-(4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl){[4-(2-butynyloxy)phenyl]sulfonyl}amino)ethanoate as a white foam. Electrospray Mass Spec 533.1 (M+H)⁺

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- Step 5** According to the procedure of **Example 11**, 0.388g (0.729 mmol) of methyl-(2R)-(4-{2-[(*tert*-butoxycarbonyl)amino]ethoxy}phenyl){[4-(2-butynyloxy)-phenyl]-sulfonyl}amino)ethanoate provided 0.378g of (2R)-(4-{2-[(*tert*-butoxy-carbonyl)-

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amino]ethoxy}phenyl)([4-(2-butynyloxy)phenyl]sulfonyl)amino)ethanoic acid as a white foam. Electrospray Mass Spec 519.4 (M+H)⁺

Step 6 According to the procedure of **Example 25**, 0.159g of (2R)-(4-{2-[(tert-butoxycarbonyl)amino]ethoxy}phenyl)([4-(2-butynyloxy)phenyl]sulfonyl)amino)-ethanoic acid provided 0.127g of *tert*-butyl 2-{4-[(1R)-1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate as a pale yellow glass. Electrospray Mass Spec 534.3 (M+H)⁺

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Example 200

(2R)-2-[4-(2-Aminoethoxy)phenyl]-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxyethanamide

Through a solution of 0.354g (0.664 mmol) of the product of **Example 199**, *tert*-butyl 2-{4-[(1R)-1-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate, in 10 mL of dichloromethane was bubbled hydrogen chloride gas for 10 minutes. The reaction was stoppered and let sit at room temperature for 30 minutes. The reaction was then diluted with 15 mL of ether and the resulting white precipitate was collected by filtration and dried in vacuo to give 0.283g of (2R)-2-[4-(2-Aminoethoxy)phenyl]-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxyethanamide as a white solid. Electrospray Mass Spec 434.3 (M+H)⁺

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Example 201

(2R)-2-[4-[2-(Acetylamino)ethoxy]phenyl]-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxyethanamide

Step 1 To a solution of 0.300g (0.564 mmol) of methyl (2R)-(4-{2-[(tert-butoxycarbonyl)amino]ethoxy}phenyl)([4-(2-butynyloxy)phenyl]sulfonyl)-amino)ethanoate (from **Example 199**) in 1.5 mL of dichloromethane was added 1.5 mL of trifluoroacetic acid and the resulting mixture was stirred for 2h at room temperature and then concentrated in vacuo. The residue was diluted with ethyl acetate and the organics were washed with saturated sodium bicarbonate solution, dried over sodium sulfate, filtered and concentrated to provide 0.244g of methyl(2R)-[4-(2-amino-

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ethoxy)phenyl]([4-(2-butynyloxy)phenyl]sulfonyl)amino)ethanoate pure enough for use in the next step. Electrospray Mass Spec 433.3 (M+H)⁺

Step 2 A solution of 0.219g (0.507 mmol) of methyl(2R)-[4-(2-aminoethoxy)-phenyl]-
5 ([4-(2-butynyloxy)phenyl]sulfonyl)amino)ethanoate in 2.5 mL of acetic anhydride and 0.25 mL of pyridine was stirred at room temperature for 15h and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:1) to provide 0.213g of methyl (2R)-{4-[2-(acetylamino)-ethoxy]phenyl}([4-(2-butynyloxy)phenyl]sulfonyl)amino)-ethanoate as a white foam.
10 Electrospray Mass Spec 475.3 (M+H)⁺

Step 3 According to the procedure of **Example 11**, 0.192g (0.405 mmol) of methyl (2R)-{4-[2-(acetylamino)ethoxy]phenyl}([4-(2-butynyloxy)phenyl]sulfonyl)-amino)-ethanoate provided 0.165g of (2R)-{4-[2-(acetylamino)ethoxy]phenyl}([4-(2-butynyloxy)phenyl]sulfonyl)amino)ethanoic acid as a white solid. Electrospray Mass
15 Spec 461.3 (M+H)⁺

Step 4 According to the procedure of **Example 25**, 0.142g of (2R)-(4-{2-[(tert-butoxycarbonyl)amino]ethoxy}phenyl)([4-(2-butynyloxy)phenyl]sulfonyl)-amino)-ethanoic acid provided 0.099g of (2R)-2-{4-[2-(Acetylamino)ethoxy]phenyl}-2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxyethanamide as a white solid.
20 Electrospray Mass Spec 498.4 (M+Na)⁺

Example 202

25 ***tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-1-piperazinecarboxylate**

According to the procedure of **Example 199**, using *tert*-butyl *N*-(2-hydroxyethyl)piperazine carbamate as the alcohol in Step 2, *tert*-butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-1-piperazinecarboxylate was obtained as a yellow solid. mp 92-95°C. Electrospray
30 Mass Spec 603.1 (M+H)⁺.

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Example 203

***tert*-Butyl 4-(2-{4-[1-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-(methyl)carbamate**

5 According to the procedure of **Example 199**, using the *t*-butyl carbamate of 2-(methylamino)ethanol as the alcohol in Step 2, *tert*-butyl 4-(2-{4-[1-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-2-(hydroxyamino)-2-oxoethyl]phenoxy]ethyl)-(methyl)-carbamate was obtained. mp 90-92°C. Electrospray Mass Spec 548.5 (M+H)⁺.

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Example 204

2- {[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}}acetamide

According to the procedure of **Example 181**, the product of **Example 203** provided 2- {[4-(2-butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-{4-[2-(methyl-
15 amino)ethoxy]phenyl}}acetamide. mp 105-108°C. Electrospray Mass Spec 448.3 (M+H)⁺.

Example 205

2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}}acetamide

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Step 1 To a 0° solution of 16.58g (0.076 mol) dissolved in 100 mL of dichloromethane was added 22.11g (0.101 mol) of di-*tert*-butyl dicarbonate followed by 25 mL (0.179 mol) of triethylamine. The reaction was stirred at 0° for 1.5h and then at room temperature for 2h. The reaction was then washed with water and brine, dried over
25 sodium sulfate, filtered and concentrated. The residue was chromatographed on silica gel eluting with hexanes/ethyl acetate (1:1) to provide methyl [(*tert*-butoxycarbonyl)-amino]4-hydroxyphenyl}acetate as a white solid.

Step 2 According to the procedure of Step 2 in **Example 199**, Mitsunobu reaction of
30 2.25g (8.0 mmol) of methyl [(*tert*-butoxycarbonyl)amino]4-hydroxyphenyl}acetate and 1.41 mL (12.0 mmol) of 1-(2-hydroxyethyl)pyrrolidine provided methyl [(*tert*-

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butoxycarbonyl)amino]{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetate after column chromatography on silica gel. Yield 65.2 Electropray Mass Spec 379.2 (M+H)⁺.

5 **Step 3** To a solution of methyl [(*tert*-butoxycarbonyl)amino]{4-[2-(1-pyrrolidinyl)-ethoxy]phenyl}acetate was dissolved in dichloromethane, hydrogen chloride gas was bubbled in for 5 minutes. The reaction was then stirred at room temperature for 0.5h. The solvent was removed to provide 1.80g of methyl amino{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetate dihydrochloride as a light pink solid Yield ~100%. mp 80°C (d). Electropray Mass Spec 279.2 (M+H)⁺.

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Step 4 To a 0° solution of methyl amino{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetate dihydrochloride (1.67g; 4.55mmol) in dichloromethane (10mL) was added 4-but-2-ynyloxy-benzenesulfonyl chloride followed by triethyl amine was dropped in. The mixture was stirred at room temperature overnight and then diluted with
15 dichloromethane. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated. The residue was purified using column chromatography on silica gel eluting with ethyl acetate to obtain 2.52g of methyl ({[4-(2-butynyloxy)phenyl]sulfonyl}amino){4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetate as an oil. Yield 92.6 %. Electropray Mass Spec 487.1 (M+H)⁺.

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Step 5 A mixture of methyl ({[4-(2-butynyloxy)phenyl]sulfonyl}amino){4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetate (2.52g, 5.19 mmol) and 5N NaOH (5.18 mL) in THF (32mL) and methanol (32 mL) was stirred at room temperature for 2h. After removing the solvent, the residue was dissolved in water and neutralized with HCl to
25 pH~ 6. The precipitated solid was filtered to provide 1.61g of ({[4-(2-butynyloxy)phenyl]sulfonyl}amino){4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetic acid as a white solid . Yield 66 %. mp 245-247°C. Electropray Mass Spec 473.2 (M+H)⁺.

Step 6 To a 0° solution of ({[4-(2-butynyloxy)phenyl]sulfonyl}amino){4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetic acid (1.58g, 3.35 mmol) and DMF (0.52 ml, 6.69 mmol) in dichloromethane (29 ml) was added oxalyl chloride (3.35ml of 2M in
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CH₂Cl₂; 6.69 mmol). The reaction mixture was stirred at 0°C for 10 minutes and at room temperature for 2h, then cooled again. A THF (2 ml) solution of triethylamine (1.87 ml 13.38 mmol) and hydroxylamine (2.05mL of 50% hydroxylamine in water, 33.5 mmol) was added in one portion. The reaction was stirred at room temperature overnight. After removing the solvent, the oily residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and evaporated. Preparative TLC chromatography eluting with dichloromethane:methanol (8:2) provided 0.33g of 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide. mp 70°C. This compound (0.28g, 0.57 mmol) was dissolved in dichloromethane (3ml) and methanol (2ml) cooled in ice bath. Then 1M hydrogen chloride in ethyl ether (0.86ml, 0.86 mmol) was dropped in. The mixture was stirred at 0°C for 10 minutes and at room temperature for 1.5h, and then concentrated to obtain 0.27g of the hydrochloride salt. mp 68-70°C. Electrospray Mass Spec 488.1 (M+H)⁺.

Example 206

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide

According to the procedure of Example 205, using 4-(2-hydroxyethyl)-morpholine as the alcohol in Step 2, provided 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide. mp 80-86°C. Electrospray Mass Spec 504.1(M+H)⁺. Hydrochloride salt mp 72 °C (d). Electrospray Mass Spec 504.1(M+H)⁺.

Example 207

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino){4-[2-(dimethylamino)ethoxy]phenyl}-N-hydroxyacetamide

According to the procedure of Example 205, using *N,N*-dimethylethanloamine as the alcohol in Step 2, provided 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino){4-[2-(dimethylamino)ethoxy]phenyl}-N-hydroxyacetamide hydrochloride. Electrospray Mass Spec 462.4 (M+H)⁺.

Example 208

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-methyl-1,3-thiazol-5-yl)ethoxy]phenyl}acetamide

5 According to the procedure of **Example 205**, using 4-methyl-5-thiazoleethanol as the alcohol in Step 2, provided 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-methyl-1,3-thiazol-5-yl)ethoxy]phenyl}acetamide as a white solid. High Resolution Mass Spec: m/z 516.12504 (M+H)⁺, calcd for C₂₄H₂₆N₃O₆S₂ 516.12576.

Example 209

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-(4-{2-[2-(2-methoxyethoxy)ethoxy]ethoxy}phenyl)acetamide

15 According to the procedure of **Example 205**, using tri(ethylene glycol)monomethylether as the alcohol in Step 2, provided 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-(4-{2-[2-(2-thoxyethoxy)methoxy]-ethoxy}-phenyl)acetamide as a yellow oil. High Resolution Mass Spec: m/z 537.1903 (M+H)⁺, calcd for C₂₅H₃₃N₂O₉S 537.19013.

Example 210

2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(2-methoxyethoxy)ethoxy]phenyl}acetamide

20 According to the procedure of **Example 205**, using di(ethylene glycol)monomethylether as the alcohol in Step 2, provided 2-([4-(2-butynyloxy)-phenyl]sulfonyl)-amino)-N-hydroxy-2-{4-[2-(2-methoxyethoxy)ethoxy]-phenyl}acetamide as a yellow
25 oil. High Resolution Mass Spec: m/z 491.15081 (M-H)⁻, calcd for C₂₃H₂₇N₂O₈S 491.14936.

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Example 211**2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-phenylacetamide**

Step 1 Solid 4-(2-butynyloxy)phenyl]sulfonyl chloride was added to excess 40% aqueous methylamine, and the resultant solution was stirred at room temperature for two hours. Evaporation under reduced pressure, followed by recrystallization from methanol gave N-methyl-[4-(2-butynyloxy)phenyl]sulfonamide] as colorless crystals, mp 78-80°C.

Step 2 A mixture of 2.39g. (10 mmol) of the above sulfonamide, 2.29g (10 mmol) of methyl alpha-bromophenylacetate, and 2.0g of powdered potassium carbonate in 10 ml of DMF was stirred at room temperature for 18 hours. The mixture was combined with 100 ml of water, and the resultant crystals were collected by filtration to give methyl 2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-phenylacetate as colorless crystals: NMR (CDCl₃) δ 1.869 (t, 3H), 2.744 (s, 3H), 3.605 (s, 3H), 4.696-4.736 (m, 2H), 5.862 (s, 1H), 7.062 (d, 2H), 7.199-7.378 (m, 5H), 7.781 (d, 2H).

Step 3 A solution of 1.50g of methyl 2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-phenylacetate and 1.50g of KOH in a methanol/water/THF mixture was stirred at room temperature for 18 hours. The solution was then evaporated, the residue was dissolved in water and then acidified with 2N hydrochloric acid, and the precipitate was collected and dried to give 1.07g of 2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-phenylacetic acid as colorless crystals, Calc'd for C₁₉H₁₉NO₅S: C, 61.11, H, 5.13, N, 3.75. Found: C, 60.66, H, 5.16, N, 3.53.

Step 4 The above acid (500 mg, 1.3 mmol) was dissolved in 5 ml dichloromethane and 1 ml DMF, and this was cooled to 0°C and a solution of 3 ml of oxalyl chloride in 5 ml dichloromethane was added slowly, and this was stirred for 45 min. at 0°C-room temperature. This mixture was evaporated under reduced pressure and the residue was dissolved in 5 ml of dichloromethane, and this solution was added at room temperature

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to a solution prepared at 0°C from 3.0 g of hydroxylamine hydrochloride in 10 ml of DMF, 15 ml of triethylamine, and 10 ml of acetonitrile. This mixture was stirred at room temperature for 18 hours, solvent was evaporated, and the residue was combined with water. Extraction of this mixture with dichloromethane, drying over sodium sulfate, and evaporation of the solvent gave 2-[[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-N-hydroxy-2-phenylacetamide as colorless crystals, Electrospray Mass Spec 389.3 (M+H)+

Example 212

2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(4-chlorophenyl)-N-hydroxyacetamide

In a similar manner as described in **Example 211**, a mixture of 2.39g N-methyl-[4-(2-butynyloxy)phenyl]sulfonamide], methyl alpha-bromo(4-chlorophenyl)acetate, and powdered potassium carbonate in DMF was stirred at room temperature for 18 hours. The mixture was combined with water and the precipitate was collected and purified by chromatography on silica gel using hexane-ethyl acetate, 4:1 to give methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(4-chlorophenyl)acetate as a yellow oil which was then used in the subsequent step without further purification.

This ester was reacted with excess methanolic lithium hydroxide at room temperature, followed by evaporation of the methanol. The residue was dissolved in water and acidified with 2N hydrochloric acid to give 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(4-chlorophenyl)acetic acid as colorless crystals, mp 170-172°C, Electrospray Mass Spec 406.4 (M-H)-

Reaction of this acid in a procedure similar to that of **Example 211**, gave 2-[[[4-(2-butynyloxy)- phenyl]sulfonyl](methyl)amino]-2-(4-chlorophenyl)-N-hydroxyacetamide as colorless crystals, Electrospray Mass Spec 423.1 (M+H)+

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Example 213**2-[[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-5-[(4-chlorophenyl)sulfanyl]-N-hydroxypentanamide**

Step 1 A solution of 7.17g (30 mmol) N-methyl-[4-(2-butynyloxy)-phenyl]-sulfonamide] in 25 ml of DMF was cooled to 0°C and 30 ml of 1M sodium hexamethyldisilazide (30 mmol) was slowly added and this mixture was stirred for 15 min and then added to a solution of 6.89 g (30 mmol) of methyl 2-bromo-5-chloropentanoate in 25 ml of DMF and was stirred at room temperature for 18 hours. The mixture was combined with water and the precipitate was collected and purified by chromatography on silica gel using hexane-ethyl acetate, 4:1 to give methyl 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)-amino]-5-chloropentanoate Electrospray Mass Spec 410.2 (M+Na)+

Step 2 A solution of 4.80 g of methyl 2-[[[4-(2-butynyloxy)phenyl]-sulfonyl]-(methyl)amino]-5-chloropentanoate of Step 1 and 15 g of sodium iodide in 25 ml of acetone was stirred at room temperature for 3 days. Solvent was removed under reduced pressure, and the residue was washed with water. The product was dried to give methyl 2-[[[4-(2-butynyloxy)phenyl]-sulfonyl](methyl)amino]-5-iodopentanoate as a pale yellow solid, Electrospray Mass Spec 480.2 (M+H)+

Step 3 A solution of 0.958 g (2.0 mmol) of methyl 2-[[[4-(2-butynyloxy)phenyl]-sulfonyl](methyl)amino]-5-iodopentanoate, 0.35 g (2.4 mmol) of 4-chlorobenzene-thiol, and 0.323 g of diisopropylethylamine in 50 ml of isopropyl alcohol was stirred at room temperature for 18 hours. Evaporation of solvent gave 0.8 g of methyl 2-[[[4-(2-butynyloxy)-phenyl]sulfonyl]-(methyl)amino]-5-[(4-chlorophenyl)-sulfanyl]-pentanoate as colorless crystals, mp 88-89°C, Electrospray Mass Spec 496.1 (M+H)+

Step 4 This ester (0.496 g) was hydrolyzed with methanolic LiOH, followed by acidification to give 2-[[[4-(2-butynyloxy)-phenyl]sulfonyl]-(methyl)amino]-5-[(4-chlorophenyl)sulfanyl]-N-methylnorvaline (0.421 g) as a colorless powder, mp 143-145°C, ESI MS m/z 480.0 (M-H) calcd. for C₂₂H₂₄ClNO₅S₂ 482.02. From 0.362 g of

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this acid, and using the procedure of Example 211 there was obtained 0.30 g of 2-[[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-5-[(4-chlorophenyl)sulfanyl]-N-hydroxypentanamide as colorless crystals, mp 144-145.5°C, Electrospray Mass Spec 497.1 (M+H)+

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Example 214

1-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide

To a solution of 0.147g (0.325 mmol) of the product of Example 58, 4-(4-but-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid tert-butyl ester, in 3.0 mL of dichloromethane was added 0.3 mL of trifluoroacetic acid and the reaction was stirred at room temperature for 1h. The reaction was then concentrated in vacuo and the residue was diluted with dichloromethane. The organics were washed with saturated sodium bicarbonate solution, dried over sodium sulfate, filtered and concentrated in vacuo to provide 0.053g of 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide as a tan solid. Electrospray Mass Spec 354.2 (M+H)+

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Example 215

1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid hydroxyamide

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Step 1 To a solution of ethyl 2-piperazinecarboxylate (0.71 g, 4.5 mmol) in toluene (8.4 mL) was added triethylamine (0.67 mL, 4.82 mmol). To this was added dropwise a solution of 4-morpholine carbonyl chloride (0.67 g, 4.51 mmol) in toluene (8.4 mL). The reaction was heated at reflux overnight and then cooled to 0 °C and filtered. The filtrate was concentrated in vacuo and purified via column chromatography on silica gel eluting with chloroform/methanol (15/1) to provide 478 mg (39%) of the acylated product, ethyl 4-(4-morpholinylcarbonyl)-2-piperazinecarboxylate, as a gold oil. Electrospray Mass Spec: 272.3 (M+H)⁺.

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Step 2 The ethyl 4-(4-morpholinylcarbonyl)-2-piperazinecarboxylate (0.41g, 1.55 mmol) was dissolved in pyridine (1.44 mL). To this solution was added a solution of

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4-but-2-ynyloxy-benzenesulfonyl chloride (0.38 g, 1.55 mmol) in pyridine (1 mL). The reaction was stirred overnight and then poured into water. The mixture was extracted three times with chloroform. The organics were combined, washed with 10% HCl, twice with water, then brine and dried over Na₂SO₄. The solution was
5 filtered and concentrated in vacuo to provide 0.6 g (81%) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid ethyl ester as a gold oil. Electrospray Mass Spec 480.2 (M+H)⁺.

Step 3 The 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-
10 piperazine-2-carboxylic acid ethyl ester (0.56 g, 1.18 mmol) was dissolved in THF/MeOH/H₂O (3 mL each) and treated with lithium hydroxide monohydrate (0.099 g, 2.3 mmol). The reaction was heated at reflux overnight and then concentrated and acidified to pH 4 with acetic acid. The solution was extracted with methylene chloride and then washed with water, brine, dried over Na₂SO₄, filtered and concentrated
15 in vacuo to provide 0.298 g (53%) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid as a yellow powder. Electrospray Mass Spec 452.2 (M+H)⁺.

Step 4 To a solution of 2M oxalyl chloride in CH₂Cl₂ (0.55mL, 1.1 mmol) at 0°C
20 was added DMF (0.085mL, 1.1 mmol) and the mixture was stirred at 0 °C for 15min, then let warm to room temperature and stirred for an additional 1h. A solution of the 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid, (0.25g, 0.554 mmol) in 2.54 mL of DMF, was then added to the reaction mixture and the reaction was stirred for 2h at room temperature.

25 In a separate flask, triethylamine (1.16mL, 8.31 mmol) was added to a 0 °C mixture of hydroxylamine hydrochloride (0.38g, 5.54 mmol) 5.23 mL of THF and 1.5 mL of water. After this mixture had stirred for 15min at 0 °C, the acid chloride solution was added to it in one portion and the resulting solution was allowed to warm to room temperature with stirring overnight. The reaction mixture next was diluted
30 with CH₂Cl₂ and washed with water and saturated sodium bicarbonate solution. The organic layer was dried over Na₂SO₄, filtered and concentrated in vacuo. The crude

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residue was triturated with ether to provide 0.161g (62%) of the 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid hydroxyamide as a beige powder. Electrospray Mass Spec 466.9 (M+H)⁺.

5

Example 216**4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diethylamide 3-hydroxyamide**

In the same manner as described in **Example 215**, using diethylcarbamoyl chloride in Step 1, the desired hydroxamic acid, 4-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diethylamide 3-hydroxyamide, was obtained as a gold oil. Electrospray Mass Spec 453.3 (M+H)⁺.

10

Example 217**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(pyrrolidine-1-carbonyl)-piperazine-2-carboxylic acid hydroxyamide**

15

In the same manner as described in **Example 215**, using 1-pyrrolidinecarbonyl chloride in Step 1, the desired hydroxamic acid, 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(pyrrolidine-1-carbonyl)-piperazine-2-carboxylic acid hydroxyamide, was obtained as a white powder. Electrospray Mass Spec 451.4 (M+H)⁺.

20

Example 218**4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diisopropylamide 3-hydroxyamide**

In the same manner as described in **Example 215**, using diisopropylcarbamoyl chloride in Step 1, the desired hydroxamic acid, 4-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diisopropylamide 3-hydroxyamide, was obtained as a white powder. Electrospray Mass Spec 481.5 (M+H)⁺.

25

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Example 219**Benzyl 4-{{4-(2-butynyloxy)phenyl}sulfonyl}-3-[(hydroxyamino)carbonyl]-1-piperazinecarboxylate**

In the same manner as described in **Example 215**, using benzyl chloroformate
5 in Step 1, the desired hydroxamic acid, benzyl 4-{{4-(2-butynyloxy)phenyl}sulfonyl}-3-[(hydroxyamino)carbonyl]-1-piperazinecarboxylate, was obtained as a white powder. Electrospray Mass Spec 488.2 (M+H)⁺.

10

Example 220**4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 3-hydroxyamide 1-(methyl-phenyl-amide)**

Step 1 The product of **Example 57**, 4-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester (3.8 g, 8.1 mmol), was dissolved
15 in dichloromethane (3 mL). To this solution was added trifluoroacetic acid (3 mL) and the reaction was allowed to stir overnight. The reaction was then concentrated in vacuo and the residue triturated with dichloromethane to provide 2.64 g (88%) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester. Electrospray Mass Spec 367.3(M+H)⁺.

20

Step 2 In the same manner as described in Step 1 of **Example 215**, the 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester (1.0 g, 2.7 mmol) was treated with N-methyl-N-phenylcarbonyl chloride to provide 1.33 g (98%) of
25 ethyl 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(methylanilino)carbonyl]-2-piperazinecarboxylate as a brown oil. Electrospray Mass Spec 500.2 (M+H)⁺.

Step 3 In the same manner as described in Step 3 of **Example 215**, the ethyl 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(methylanilino)carbonyl]-2-piperazinecarboxylate (1.28g, 2.57 mmol) provided 0.84 g (69%) of the 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(methylanilino)carbonyl]-2-yl]-2-piperazinecarboxylic acid as a beige
30 powder. Electrospray Mass Spec 472.2 (M+H)⁺.

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Step 4 In the same manner as described in Step 4 of **Example 215**, the 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(methylanilino)carbonyl]-2-yl}-2-piperazinecarboxylic acid (0.74 g, 1.57 mmol) provided 0.45 g (59%) of 4-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 3-hydroxyamide 1-(methyl-phenyl-amide) as a beige powder. Electrospray Mass Spec 487.1 (M+H)⁺.

Example 221

4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-3-hydroxy-N-1-(4-methoxyphenyl)-1,3-piperazinedicarboxamide

Step 1 To a solution of p-anisidine (0.5 g, 4.06 mmol) in dichloromethane (21 mL) was added pyridine (0.36 mL, 4.46 mmol) followed by 4-nitrophenylchloroformate (0.9 g, 4.46 mmol). The reaction was stirred for 72 hours and then diluted with dichloromethane, washed with water, brine, dried over MgSO₄ to provide 1.2 g (100%) of the desired carbamate as a solid.

To a solution of the carbamate (0.5 g, 1.75 mmol) in chloroform (41 mL) was added triethylamine (0.32 mL, 2.2 mmol) followed by trimethylsilyl chloride (0.24 mL, 1.9 mmol). The reaction was stirred for five hours at which time 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester from Step 1, **Example 220**, (0.6 g, 1.6 mmol) was added. The reaction was stirred overnight and then diluted with chloroform, washed with water, brine, dried over Na₂SO₄, filtered, concentrated in vacuo and purified via column chromatography on silica gel eluting with dichloromethane:methanol (90:10) to provide 0.44 g (48%) of ethyl 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(4-methoxyanilino)carbonyl]-2-piperazinecarboxylate as a gold sap. Electrospray Mass Spec 516.2 (M+H)⁺.

Step 2 In the same manner as described in Step 3 of **Example 215**, the ethyl 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(4-methoxyanilino)carbonyl]-2-piperazinecarboxylate (0.40 g, 0.78 mmol) provided 0.066 g (17%) of the 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(4-methoxyanilino)carbonyl]-2-piperazinecarboxylic acid. Electrospray Mass Spec 488.1 (M+H)⁺.

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Step 3 In the same manner as described in Step 4 of **Example 215**, the 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(4-methoxyanilino)carbonyl]-2-piperazinecarboxylic acid (0.067 g, 0.14 mmol) provided 0.033 g (50%) of the 4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-3-hydroxy-N-1-(4-methoxyphenyl)-1,3-piperazine-dicarboxamide as a brown powder. Electrospray Mass Spec 503.6 (M+H)⁺.

Example 222

4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-1-(4-fluorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide

Step 1 In the same manner as described in Step 1 of **Example 221**, 4-fluoroaniline (0.60 g, 5.4 mmol) and 4-nitrophenylchloroformate provided 1.29g (87%) of the desired carbamate as a yellow powder. Electrospray Mass Spec 276.1 (M-H)⁻.

The carbamate (1.15 g, 4.16 mmol) was reacted with ethyl 2-piperazine-carboxylate, also as in Step 1 of **Example 221**, to provide 0.451 g (37%) of the desired urea, ethyl 4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylate, as a gold oil. Electrospray Mass Spec 296.3 (M+H)⁺.

Step 2 In the same manner as described in Step 2 of **Example 215**, ethyl 4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylate (0.41 g, 1.4 mmol) and 4-but-2-ynyloxy-benzenesulfonyl chloride provided 0.49 g (70%) of ethyl 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylate as a white powder. Electrospray Mass Spec 504.4 (M+H)⁺.

Step 3 In the same manner as described in Step 3 of **Example 215**, ethyl 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylate (0.45 g, 0.91 mmol) provided 0.026 g (61%) of 1-{{4-(2-butynyloxy)phenyl}sulfonyl}-4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylic acid. Electrospray Mass Spec 476.4 (M+H)⁺.

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Step 4 In the same manner as described in Step 4 of **Example 215**, 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(4-fluoroanilino)carbonyl]-2-piperazinecarboxylic acid (0.24 g, 0.50 mmol) provided 0.080 g (32%) of 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-1-(4-fluorophenyl)-N-3-hydroxy-1,3- piperazinedicarboxamide as a yellow powder.

5 Electrospray Mass Spec 491.4 (M+H)⁺.

Example 223

4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-1-(3,5-dichlorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide

10 **Step 1** To a solution of ethyl 2-piperazinecarboxylate (0.9 g, 5.7 mmol) in chloroform (11 mL) was added 3,5-dichlorophenyl isocyanate (1.05 g, 5.7 mmol). The reaction was stirred overnight after which time a precipitate had formed. The reaction was concentrated and the solid was chromatographed on silica gel using ethyl acetate as eluant to provide 0.53 g (27%) of ethyl 4-[(3,5-dichloroanilino)carbonyl]-2-piperazinecarboxylate as an off white powder. Electrospray Mass Spec 346.1 (M+H)⁺.

Step 2 In the same manner as described in Step 2 of **Example 215**, ethyl 4-[(3,5-dichloroanilino)carbonyl]-2-piperazinecarboxylate (0.49 g, 1.42 mmol) and 4-but-2-ynyloxy-benzenesulfonyl chloride provided 0.73 g (92%) of the desired sulfonamide.

20 Electrospray Mass Spec 554.1 (M+H)⁺.

Step 3 In the same manner as described in Step 3 of **Example 215**, the sulfonamide (0.64 g, 1.14 mmol) provided 0.54 g (90%) of 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(3,5-dichloroanilino)carbonyl]-2- piperazinecarboxylic acid. Electrospray Mass

25 Spec 527.9 (M+H)⁺.

Step 4 In the same manner as described in Step 4 of **Example 215**, the 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-4-[(3,5-dichloroanilino)carbonyl]-2- piperazinecarboxylic acid (0.46 g, 0.88 mmol) provided 0.150 g (31%) of 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-1-(3,5-dichlorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide as a white powder. Electrospray Mass Spec 540.8 (M+H)⁺.

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Example 224**4-Acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid
hydroxyamide**

- 5 **Step 1** To a solution of 0.170g (0.466 mmol) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester in 10 mL of dichloromethane cooled at 0° was added 0.2 mL of triethylamine, 0.05g of DMAP and 0.3 mL (0.93 mmol) of acetyl chloride. After stirring for 13h the mixture was diluted with ethyl acetate and washed with saturated aqueous sodium bicarbonate. The organic layer was dried over sodium
- 10 sulfate, filtered and concentrated in vacuo. The resulting residue was chromatographed on silica gel eluting with ethyl acetate/ hexanes (2:1) to provide 0.13g (68%) of 4-acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester as a brown oil. Electrospray Mass Spec: 409.3 (M+H)+
- 15 **Step 2** According to the procedure of **Example 54**, 0.151g (0.369 mmol) of 4-acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester provided 0.107g (76%) of the carboxylic acid, 4-acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid, as a brown oil. Electrospray Mass Spec: 381.3 (M+H)+
- 20 **Step 3** According to the procedure of **Example 25**, 0.1157g (0.304 mmol) of 4-acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid followed by flash chromatography with methylene chloride/ methanol (10:1) provided 0.082g (68%) of the hydroxamic acid, 4-acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-
- 25 piperazine-2-carboxylic acid hydroxyamide, as a brown solid. Electrospray Mass Spec: 396.3 (M+H)+

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Example 225**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-propionyl-piperazine-2-carboxylic acid hydroxyamide**

According to the procedure of **Example 224**, using propionyl chloride in Step 1, 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-propionyl-piperazine-2-carboxylic acid hydroxyamide was obtained as a grey solid. Electrospray Mass Spec: 410.3 (M+H)+

Example 226**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(thiophene-2-carbonyl)-piperazine-2-carboxylic acid hydroxyamide**

According to the procedure of **Example 224**, using thiophene-2-carbonyl chloride in Step 1, 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-(thiophene-2-carbonyl)-piperazine-2-carboxylic acid hydroxyamide was obtained as a grey solid. Electrospray Mass Spec: 464.3 (M+H)+

Example 227**1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methanesulfonyl-piperazine-2-carboxylic acid hydroxyamide**

According to the procedure of **Example 224**, using methanesulfonyl chloride in Step 1, 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-methanesulfonyl-piperazine-2-carboxylic acid hydroxyamide was obtained as a white powder. Electrospray Mass Spec: 432.1 (M+H)+

Example 228**4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid methyl ester**

According to the procedure of **Example 224**, using methyl chloroformate in Step 1, 4-(4-but-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid methyl ester was obtained as a grey powder. Electrospray Mass Spec: 412.2 (M+H)+

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Example 229**{2-[4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazin-1-yl]-2-oxo-ethyl}-carbamic acid *tert*-butyl ester**

To a solution of 0.14g (0.8 mmol) of N-(*tert*-butoxycarbonyl)glycine dissolved
5 in 3 mL of DMF was added 0.13g (0.963 mmol) of 1-hydroxybenzotriazole hydrate
(HOBt) followed by 0.203g (1.06 mmol) of 1-(3-dimethylaminopropyl)-3-
ethylcarbodiimide hydrochloride (EDC). The resulting mixture was stirred at room
temperature for 1h and 0.191g (0.522 mmol) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-
piperazine-2-carboxylic acid ethyl ester in 3 mL of DMF was added dropwise. After
10 stirring the reaction for 14h the solution was diluted with ethyl acetate and washed
with water. The organic layer was dried over sodium sulfate, filtered and concentrated
in vacuo. The resulting residue was chromatographed on silica gel eluting with ethyl
acetate/ hexanes (1:1) to provide 0.26g (95%) of the sulfonamide, ethyl 4-{2-[(*tert*-
butoxycarbonyl)amino]acetyl}-1-[[4-(2-butynyloxy)phenyl]sulfonyl]-2-piperazine-
15 carboxylate, as a clear oil. Electrospray Mass Spec: 524.2 (M+H)+

Hydrolysis of the carboxylic acid and subsequent conversion into the
corresponding hydroxamic acid, as in **Example 224**, provided {2-[4-(4-but-2-ynyloxy-
benzenesulfonyl)-3-hydroxycarbamoyl-piperazin-1-yl]-2-oxo-ethyl}-carbamic acid
tert-butyl ester as a grey powder. Electrospray Mass Spec: 511.1 (M+H)+

20

Example 230**4-Aminoacetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid
hydroxyamide**

To a solution of 0.157g (0.31 mmol) of the product of **Example 229**, {2-[4-(4-
25 but-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazin-1-yl]-2-oxo-ethyl}-
carbamic acid *tert*-butyl ester, in 4.0 mL of methylene chloride was added 1.0 mL of
trifluoroacetic acid. The resulting solution was stirred at room temperature for 1h and
then reduced to dryness. The resulting residue was dissolved in ethyl acetate and
washed with saturated aqueous sodium bicarbonate and then brine. The organic layer
30 was dried over sodium sulfate, filtered and concentrated in vacuo to furnish 0.121g

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(95%) of 4-aminoacetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide as a yellow solid. Electrospray Mass Spec: 411.1 (M+H)+

Example 231

5 **1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-4-[(2,2,5-trimethyl-1,3-dioxan-5-yl)carbonyl]-2-piperazinecarboxamide}**

According to the procedure of Example 229, using 2,2,5-trimethyl-[1,3]-dioxane-5-carboxylic acid, the hydroxamic acid 1-{{[4-(2-butynyloxy)-phenyl]-sulfonyl}-N-hydroxy-4-[(2,2,5-trimethyl-1,3-dioxan-5-yl)carbonyl]-2-piperazine-
10 carboxamide was obtained as a white solid. Electrospray Mass Spec: 510.2 (M+H)+

Example 232

1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-4-[3-hydroxy-2-(hydroxymethyl)-2-methylpropanoyl]-2-piperazinecarboxamide}

15 To a solution of the product of Example 231 in 5mL of THF was added 0.5 mL of 1.0M hydrogen chloride in ether. The resulting solution was stirred at room temperature for 20h and then concentrated in vacuo furnishing 0.054g (99%) of the diol, 1-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-4-[3-hydroxy-2-(hydroxymethyl)-2-methylpropanoyl]-2-piperazinecarboxamide, as a white solid. Electrospray
20 Mass Spec: 470.2 (M+H)+

Example 233

4-(4-Bromo-benzyl)-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide

25 To a solution of 0.30g (0.820 mmol) of 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester (Step 1, Example 220) in 10 mL of DMF was added 0.339g (2.459 mmol) of potassium carbonate followed by 0.205g (0.820 mmol) of p-bromobenzyl bromide. The reaction was stirred at room temperature for 15h, then diluted with ether and water. The organics were washed with water, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica
30 gel eluting with ethyl acetate/hexanes (1:1) to provide 0.438g of 4-(4-bromo-benzyl)-

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1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester as a colorless oil. Electrospray Mass Spec 534.9, 536.8 (M+H)+

Hydrolysis of the carboxylic acid following the procedure of **Example 11** and subsequent conversion into the corresponding hydroxamic acid, as in **Example 9**,
5 provided 4-(4-bromo-benzyl)-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide as a tan foam. Electrospray Mass Spec: 521.98, 523.91 (M+H)+

Example 234

10 **1-(4-But-2-ynyloxy-benzenesulfonyl)-4-pyridin-3-ylmethyl-piperazine-2-carboxylic acid hydroxyamide**

Following the procedure of **Example 233**, using 3-picolyl chloride hydrochloride to alkylate 1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid ethyl ester, 1-(4-but-2-ynyloxy-benzenesulfonyl)-4-pyridin-3-ylmethyl-piperazine-
15 2-carboxylic acid hydroxyamide was obtained as a white solid. Electrospray Mass Spec: 445.1 (M+H)+

Example 235

20 **(3S)-4-([4-(2-Butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide**

Step 1 A solution of D-penicillamine (0.5g, 3.35 mmol) in methanol (5ml) was cooled to 0°C and crushed sodium hydroxide (0.28g, 6.87 mmol) was added to give a clear solution. 2-Bromoethanol (0.26ml, 3.71 mmol) was added and the reaction was stirred at 0°C for 1 hour and then at room temperature for an additional 1.5 hours. The
25 solvent was evaporated and the oily residue was dissolved in 3 mL water and 6 mL DMF and stirred with sodium carbonate (0.82g 7.2 mmol) and 4-butynyloxy-benzenesulfonyl chloride (0.78g, 3.18 mmol) at room temperature overnight. After evaporating the solvent, the residue was diluted with ethyl acetate and water. The aqueous layer was acidified to pH~3 with concentrated HCl and extracted with
30 dichloromethane. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated to obtain 1.2g of (2S)-2-{[4-(2 butynyloxy)-

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phenyl)sulfonyl} amino)-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoic acid as an oil.
Yield 89.6%. Electrospray Mass Spec 400.1 (M-H).

Step 2 To a solution of (2S)-2-([4-(2-butynyloxy)phenyl)sulfonyl} amino)-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoic acid (1.2g, 2.99mmol) in dimethylacetamide (8mL) was added potassium carbonate (3.3g, 23.9mmol); benzyltriethylammonium chloride (0.20g, 0.90 mmol) and 2-bromo-2methyl-propane (5.5mL, 47.9mmol). The mixture was heated at 50°C overnight, cooled to room temperature and diluted with ethyl acetate. The organics were washed with water and brine, dried over sodium sulfate, filtered and evaporated to provide 1.10 g of *tert*-butyl (2S)-2-([4-(2-butynyloxy)phenyl)sulfonyl}-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoate as an oil. Yield ~80.9%. Electrospray Mass Spec 458.2(M+H)⁺.

Step 3 To a THF solution (15 mL) of *tert*-butyl (2S)-2-([4-(2-butynyloxy)phenyl)sulfonyl}-3-[(2-hydroxyethyl)sulfanyl]-3-methylbutanoate (0.59g, 1.29 mmol) and triphenylphosphine (0.51g, 1.94 mmol), diethylazodicarboxylate (0.31 mL, 1.94mmol) was slowly added. The mixture was stirred at room temperature overnight. After removing the solvent, the residue was diluted with ethyl acetate. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated. The residue was purified by column chromatography on silica gel eluting with hexanes:ethyl acetate (4:1) to give 0.36g of *tert*-butyl (3S)-4-([4-(2-butynyloxy)phenyl)sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate. Yield 64.3%. Electrospray Mass Spec 440.1 (M+H)⁺.

Step 4 To a solution of *tert*-butyl 4-([4-(2-butynyloxy)phenyl)sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate (0.31g, 0.71 mmol) in dichloromethane (7mL) was added trifluoroacetic acid (3mL) and the resulting mixture was stirred at room temperature for 1 hour, after which the solvents were evaporated and toluene was added. The toluene and excess trifluoroacetic acid were removed to give 0.25 g of (3S)-4-([4-(2-butynyloxy)phenyl)sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic

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acid, which was used for the next step without further purification. Yield: 92.6 %. mp 129-131°C. %. Electrospray Mass Spec 381.8(M-H)⁻.

Step 5 To a 0°C solution of 4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid (6a) (0.25g, 0.65mmol) in dichloromethane (5mL) and DMF (0.1mL, 1.31mmol), oxalyl chloride (0.65mL of 2M in CH₂Cl₂; 1.31 mmol) was added dropwise. The reaction mixture was stirred at 0°C for 10 minutes and at room temperature for 2 hours, then recooled to 0°C. A THF (1 mL) solution of triethylamine (0.34mL, 2.61 mmol) and hydroxylamine (0.24mL of 50% hydroxylamine in water, 3.92 mmol) was added in one portion. The reaction was stirred at room temperature overnight. After removing the solvent, the oily residue was diluted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and evaporated to give 0.18g of a solid which was triturated with ether to give 0.14g of (3S)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide as a white solid. Yield 55%. mp 185-186°C. Electrospray Mass Spec 399.1(M+H)⁺

Example 236

9-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-6-thia-9-azaspiro[4,5]decane-10-carboxamide

According to the procedure of Example 235, using alpha-amino-1-mercaptopentaneacetic acid (Reich, et al. *Bioorg. Med. Chem. Lett.* 4(9) 1167 (1994)), the desired 9-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-6-thia-9-azaspiro[4,5]-decane-10-carboxamide was obtained. mp 206-208°C. Electrospray Mass Spec 425(M+H)⁺.

Example 237

9-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-1-thia-4-azaspiro[5,5]undecane-5-carboxamide

According to the procedure of Example 235, using alpha-amino-1-mercaptopentaneacetic acid (Reich, et al. *Bioorg. Med. Chem. Lett.* 4(9) 1167 (1994)), the

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desired 9-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-1-thia-4-azaspiro [5,5]undecane-5-carboxamide was obtained. mp 117-119°C. Electrospray Mass Spec 480(M+H)⁺.

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Example 238**4-([4-(2-Butynyloxy)phenyl]sulfonyl)-2,2-diethyl-thiomorpholine-3-carboxylic acid hydroxyamide**

According to the procedure of **Example 235**, using 3-ethyl-3-sulfanylnorvaline (Reich, et al. *Bioorg. Med. Chem. Lett.* 4(9) 1167 (1994)), the desired 4-([4-(2-butynyloxy)phenyl]sulfonyl)-2,2-diethyl-thiomorpholine-3-carboxylic acid hydroxy-
10 amide was obtained. mp 212-214 °C. Electrospray Mass Spec 427.1(M+H)⁺.

Example 239**4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-thiomorpholine-3-carboxamide**
15

According to the procedure of Steps 1 and 2 of **Example 235**, using D-cysteine, the desired *tert*-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-{3-[(2-hydroxyethyl)thio]propanoate was obtained. Electrospray Mass Spec 430.2 (M+ H)⁺.

To a solution of *tert*-butyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-{3-
20 [(2-hydroxyethyl)thio]propanoate (0.5g, 1.16 mmol) and carbon tetrabromide (0.38g, 1.16mmol) in dichloromethane (3 mL), a dichloromethane solution (1mL) of triphenylphosphine was added dropwise. The reaction mixture was stirred at 0 C for 10 minutes and at room temperature overnight. After removing the solvent, the oily residue was separated by column chromatography on silica gel eluting with hexane:ethyl acetate
25 (3:2) to give 0.33g of *tert*-butyl S-(2-bromoethyl)-N-([4-(2-butynyloxy)phenyl]sulfonyl) cysteine. Yield~57.8%. Electrospray Mass Spec 492.1; 494.1 (M+ H)⁺.

To a solution of *tert*-butyl S-(2-bromoethyl)-N-([4-(2-butynyloxy)-phenyl]-sulfonyl)-cysteine (0.31g, 0.63mmol) dissolved in DMF and cooled in an ice bath was added 3 equivalents of potassium carbonate and the reaction was stirred at room
30 temperature for 1 hour. After removing the solvent, the residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried

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over sodium sulfate, filtered and concentrated to give 0.25g of *tert*-butyl 4-([4-(2-butynyloxy)phenyl]sulfonyl)-thiomorpholine-3-carboxylate as an oil. Yield ~ 100%. Electrospray Mass Spec 412.3 (M+H)⁺.

According to the procedures of Steps 4 and 5 of **Example 235**, *tert*-butyl 4-
5 ([4-(2-butynyloxy)phenyl]sulfonyl)-thiomorpholine-3-carboxylate was converted into 4-([4-(2-butynyloxy)phenyl]sulfonyl)-N-hydroxy-thiomorpholine-3-carboxamide. mp 150-154°C. Electrospray Mass Spec 371.2 (M+H)⁺.

Example 240

10 4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-3-morpholinecarboxamide

Step 1 To a 0° solution of D-serine methyl ester hydrochloride (0.62g, 4mmol) in 5mL of dichloromethane was added triethylamine (1.67mL, 12mmol) followed by a dichloromethane (6mL) solution of 4-(2-butynyloxy)-benzenesulfonyl chloride (0.98g, 4mmol). The reaction was stirred at room temperature overnight and then the mixture
15 was poured into water. The organic layer was washed with 2N citric acid, water and brine, dried over sodium sulfate, filtered and concentrated to give 1.16g of methyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-3-hydroxypropanoate. Yield~89.2%. mp 72-74°C. Electrospray Mass Spec 328.2 (M+H)⁺.

Step 2 To a THF solution (10mL) of methyl 2-([4-(2-butynyloxy)phenyl]-sulfonyl)-amino)-3-hydroxypropanoate (0.33g, 1 mmol) and triphenylphosphine (0.32g, 1.2 mmol), diethylazodicarboxylate (0.19mL, 1.2 mmol) was added dropwise. The mixture was stirred at room temperature overnight. After removing the solvent, the residue was extracted with ether. The organic layer was washed with 1N NaHCO₃, water and
25 brine, dried over sodium sulfate, filtered and concentrated. The residue was purified by column chromatography on silica gel eluting with hexane:ethyl acetate (1:1) to provide 0.18g of 1-([4-(2-butynyloxy)phenyl]sulfonyl)-2-aziridinecarboxylic acid, methyl ester. Yield 58.0%. Electrospray Mass Spec 310.2(M+H)⁺.

Step 3 To a 0° solution of 1-([4-(2-butynyloxy)phenyl]sulfonyl)-2-aziridinecarboxylic acid, methyl ester (0.55g, 1.78mmol) in 2-bromoethanol (1.26mL,

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17.8mmol) was dropwise added boron trifluoride etherate (0.18mL). The mixture was stirred at 0°C for 30 minutes and stirred at room temperature for 6 hours. The reaction was diluted with ethyl acetate. The organic layer was washed with 1N NaHCO₃, water and brine, dried over Na₂SO₄, filtered and concentrated. The residue was purified by column chromatography on silica gel eluting with hexane:ethyl acetate (7:3) to obtain 0.2g of 3-(2-bromo-ethoxy)-2-(4-[2-butynyloxy]-benzene-sulfonyl-amino)propionic acid methyl ester. Yield: 26%. mp 45-46°C. Electrospray Mass Spec 434.1.436.1 (M+H)⁺.

10 **Step 4** To a solution of 3-(2-bromo-ethoxy)-2-(4-[2-butynyloxy]-benzenesulfonyl-amino)-propionic acid methyl ester (0.15g, 0.35 mmol) dissolved in DMF (2 mL) and cooled in an ice bath was added potassium carbonate (0.16g, 1.15 mmol) and the reaction was stirred at room temperature for 1 hour. After removing the solvent, the residue was extracted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered, and concentrated to give 0.09g of 4-([4-(2-butynyloxy)phenyl]sulfonyl)-morpholine-3-carboxylic acid, methyl ester as an oil. Yield ~ 73.8%. Electrospray Mass Spec 354.2 (M+H)⁺.

20 **Step 5** A solution of 4-([4-(2-butynyloxy)phenyl]sulfonyl)-morpholine-3-carboxylic acid, methyl ester (0.1g, 0.28mmol) in 2.4 mL of THF:methanol:water [4:1:1] was cooled in an ice bath and 2N LiOH (0.3mL, 0.59mmol) was added. The reaction was stirred at 0°C for 30 minutes and at room temperature for 2 hours. After evaporating the solvent, the residue was diluted with ether and filtered. The solid was dissolved in water, neutralized with 1N HCl to pH~3 and extracted with dichloromethane. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and concentrated to give 0.06g of 4-([4-(2-butynyloxy)phenyl]sulfonyl)-morpholine-3-carboxylic acid. Yield~69.8%. mp 40-42°C. Electrospray Mass Spec 338.1(M-H)⁻.

30 **Step 6** A solution of 4-([4-(2-butynyloxy)phenyl]sulfonyl)-morpholine-3-carboxylic acid (0.52g, 1.53mmol) and DMF (0.24mL, 3.1mmol) in dichloromethane (6mL) was cooled in an ice bath and oxalyl chloride (1.54 mL of 2M in CH₂Cl₂; 3.1 mmol) was

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added dropwise. The reaction mixture was stirred at 0°C for 10 minutes and at room temperature for 2 hours and then recooled to 0°. A THF (4.5 mL) solution of triethyl amine (0.86mL, 6.13mmol) and hydroxylamine (0.56mL of 50% hydroxyamine in water, 9mmol) was added in one portion. The reaction was stirred at room temperature overnight. After removing the solvent, the oily residue was diluted with ethyl acetate and water. The organic layer was washed with water and brine, dried over sodium sulfate, filtered and evaporated to obtain 0.42g of 4-([4-(2-butyloxyphenyl)sulfonyl]-N-hydroxy-3-morpholinecarboxamide. Yield ~ 77.8%. mp 68-72°C. Electrospray Mass Spec 355.2(M+H)⁺.

Example 241

9-Benzyl-4-([4-(2-butyloxyphenyl)sulfonyl]-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide

Step 1 To a stirred suspension of sodium hydride (4.6g of 60% oil dispersion, 100 mmol) in dry THF (200 ml) at 0°C were added simultaneously, in a dropwise manner, ethyl isocyanatoacetate (10.3g, 100 mmol) and 1-benzyl-4-piperidone (17.5g, 100 mmol). After the addition reaction mixture was warmed up to room temperature and stirred for 4h. The reaction mixture was then carefully quenched with saturated ammonium chloride solution. The reaction mixture was extracted with chloroform and washed with saturated brine solution. The organic layer was dried over anhydrous MgSO₄, filtered and concentrated. The crude brown oil, ethyl(1-benzyl-4-piperidinylidene)(formylamino)acetate, was pure enough for use in the next step. Yield, 28.9 g (96%); Electrospray Mass Spec: 303 (M+H)⁺.

Step 2 A mixture of ethyl(1-benzyl-4-piperidinylidene)(formylamino)acetate (3.0g, 10.0 mmol), 2-mercaptoethanol (2.7g, 35 mmol) and sodium methoxide (1g) was heated at 80°C for 8h under nitrogen. The reaction mixture was then cooled to room temperature and quenched with saturated ammonium chloride solution. It was extracted with chloroform, washed twice with brine and dried over anhydrous Na₂SO₄, filtered and concentrated. The oily residue was purified by silica gel column chromatography eluting with 5% methanol:chloroform to provide ethyl {1-benzyl-4-

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[(2-hydroxyethyl)sulfanyl]-4-piperidiny] (formylamino)acetate as a yellow oil; Yield: 2.8 g (73%); Electrospray Mass Spec: 381 (M+H)⁺.

Step 3 Ethyl {1-benzyl-4-[(2-hydroxyethyl)sulfanyl]-4-piperidiny] (formylamino)-

5 acetate (2.8g, 7.3 mmol) was dissolved in 50 ml of ethanol and 5N hydrochloric acid (4 ml) and refluxed for 2h. The reaction mixture was then concentrated to dryness to provide ethyl amino {1-benzyl-4-[(2-hydroxyethyl)sulfanyl]-4-piperidiny] acetate as a brown oil which was used for the next step with out purification. Yield: 3.0 g (quantitative); Electrospray Mass Spec: 353 (M+H)⁺.

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Step 4 To a stirred solution of ethyl amino {1-benzyl-4-[(2-hydroxyethyl)sulfanyl]-4-piperidiny] acetate (2.1g, 5 mmol) and 4-but-2-ynyloxy benzenesulfonyl chloride (1.24g, 5.1 mmol) in dichloromethane (200 ml) at 0°C, *N,N*-diisopropylethylamine (3.0g, 23.6 mmol) was added slowly. After the addition, the reaction mixture was stirred at room temperature for 4h and quenched with water. The reaction mixture was washed with water, dried over anhydrous MgSO₄, filtered and concentrated. It was purified by silica gel column chromatography eluting with 80% ethyl acetate:hexane to give ethyl {1-benzyl-4-[(2-hydroxyethyl)sulfanyl]-4-piperidiny] ([4-(2-butynyloxy)phenyl]sulfonyl)amino)acetate as a brown oil; Yield: 1.0 g (85%);

15

20 Electrospray Mass Spec: 561 (M+H)⁺.

Step 5 A mixture of ethyl {1-benzyl-4-[(2-hydroxyethyl)sulfanyl]-4-piperidiny] ([4-(2-butynyloxy)phenyl]sulfonyl)amino)acetate (5.0g, 8.9 mmol), tributylphosphine (4.04g, 20 mmol) and 1,1'-(azodicarbonyl)-dipiperidine (5.04g, 20 mmol) was stirred in dry THF at room temperature for 6h. The reaction mixture was quenched with water, extracted with chloroform and washed well with water. The organic layer was dried over anhydrous MgSO₄, filtered and concentrated. The product was purified by silica gel column chromatography eluting with 60% ethyl acetate/hexane to give ethyl-9-benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxylate as a pale yellow oil; Yield: 4.2 g (87.5%); Electrospray Mass Spec: 543 (M+H)⁺.

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Step 6 A mixture of ethyl-9-benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxylate (4.0g, 7.38 mmol) and 5N sodium hydroxide (20 ml) was refluxed in THF:methanol (1:1, 100 ml) for 8h. The reaction mixture was concentrated and the residue was carefully neutralized with concentrated hydrochloric acid. The separated sticky mass was extracted with chloroform, washed once with water, dried over anhydrous MgSO_4 , filtered and concentrated. The brown spongy solid, 9-benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1-thia-4,9-diazaspiro[5.5]-undecane-5-carboxylic acid, was used for the next step with out purification. Yield: 3.5 g (93%); mp 123-128°C; Electrospray Mass Spec: 515 (M+H)⁺.

Step 7 To a stirred suspension of 9-benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxylic acid (3.0g, 5.8 mmol) in dichloromethane (200 ml)/ DMF (5 ml), oxalyl chloride (5.0g, 39.6 mmol) in dichloromethane (10 ml) was added slowly at 0° C. After the addition, the reaction mixture was stirred at room temperature for 1h. In a separate flask, hydroxylamine hydrochloride (6.9g, 100 mmol) was dissolved in DMF/acetonitrile (1:1, 100 ml) and triethylamine (20g, 200 mmol) was added. It was stirred at room temperature for 1h and diluted with dichloromethane (50 ml). The acid chloride formed was concentrated to dryness and redissolved in dichloromethane. The hydroxylamine solution was cooled to 0°C, and the acid chloride was added to the hydroxylamine. The reaction mixture was stirred at room temperature for 6h and concentrated to dryness. It was extracted with chloroform, washed well with water, dried over anhydrous MgSO_4 , filtered and concentrated. The product was purified by silica gel column chromatography eluting with 5% methanol:chloroform. The hydrochloride salt was prepared by dissolving the free base in methanolic hydrochloric acid to give 9-benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide hydrochloride as a yellow spongy solid; Yield 1.8 g (58%); mp 151-153°C; Electrospray Mass Spec: 530 (M+H)⁺; ¹H NMR (DMSO) δ : 1.8 (s, 3H), 1.9 (m, 2H), 2.3-2.6 (m, 4H), 2.7 -2.85 (m, 3H), 3.0-3.1 (m, 1H), 3.5 (s, 2H), 3.8-4.2 (m, 2H), 4.7 (s, 1H), 4.8 (s, 2H), 7.0 (d, 2H), 7.3-7.5 (m, 5H), 7.8 (d, 2H), 10.6 (s, 1H), 11.1 (s, 1H).

Example 242**9-methyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide**

- 5 9-Methyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide was prepared according to the procedure of **Example 241**. Starting from ethyl isocyanatoacetate and 1-methyl-4-piperidone, 9-methyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide was isolated as white solid. mp 195-198; Electrospray Mass
- 10 Spec: 454 (M+H)⁺. H¹ NMR (DMSO) δ: 1.8 (s, 3H), 1.9 (m, 2H), 2.3-2.6 (m, 4H), 2.7-2.85 (m, 3H), 3.0-3.1 (m, 1H), 3.5 (s, 2H), 3.8-4.2 (m, 2H), 4.7 (s, 1H), 4.8 (s, 2H), 7.0 (d, 2H), 7.3-7.5 (m, 5H), 7.8 (d, 2H), 10.6 (s, 1H), 11.1 (s, 1H).

Example 243

- 15 **N-Hydroxy-2,2-dimethyl-4-[(4-{{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl]sulfonyl}-3-thiomorpholine carboxamide**

- Step 1** To a solution of 8.0mL (51mmol) of 2-(3-butynyloxy)tetrahydro-2H-pyran in 150mL of THF under nitrogen atmosphere at -23°C was added dropwise a solution of 33 mL (53 mmol) of 1.6M butyllithium in hexanes, maintaining the temperature at
- 20 -23°C. The resulting solution was stirred at 0°C for 2h, recooled to -23°C and 2.4g (76.5 mmol) of paraformaldehyde was added in several portions. The mixture was stirred at -23°C for 1h and let warm to room temperature and stirred for 18h. The reaction mixture was poured into a large excess of ice water and extracted with ether. The organics were washed with brine until neutral, dried over MgSO₄, filtered and
- 25 concentrated in vacuo. The residue was kugelrohr distilled to provide 7.26g (77%) of 5-(tetrahydro-2H-pyran-2-yloxy)-2-pentyn-1-ol as a colorless liquid. EI Mass Spec: 185.1 (M+H)⁺

- Step 2** To a stirred solution of 5.15 mL (59.8 mmol) of 1,2-dibromoethane in 50 mL
- 30 of DMF at room temperature was added over 45min a solution of 10g (50 mmol) of D-penicillamine methyl ester hydrochloride and 22.5 mL (150.45 mmol) of 1,8-

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diazabicyclo[5.4.0]undec-7-ene in 100 mL of DMF. The reaction was stirred for 2.5h, poured into a solution of saturated NaHCO₃ and extracted with ethyl acetate. The organics were washed with brine, dried over MgSO₄, filtered and concentrated in vacuo to provide 8.24g (87%) of methyl (3S)-2,2-dimethyl-3-thiomorpholine carboxylate as a pale yellow oil. Electrospray Mass Spec: 190.1 (M+H)⁺

Step 3 To a solution of 0.5g (2.6mmol) of 4-hydroxybenzenesulfonyl chloride (*J. Org. Chem.* 1973, 38, 1047) in 5 mL of chloroform at room temperature was added 0.706 mL (2.86 mmol) of N,O-bis(trimethylsilyl)acetamide. The reaction mixture was stirred for 1h and added a solution of 0.41g (2.16mmol) of methyl (3S)-2,2-dimethyl-3-thiomorpholinecarboxylate in 1 mL of chloroform in one portion, followed by 0.48 mL (4.37 mmol) of N-methylmorpholine. The resulting mixture was stirred for 18h and 10 mL of methanol was added and the resulting mixture was heated to reflux for 1h. The reaction was diluted with ethyl acetate, washed with water, 5% HCl and brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was triturated with ether:hexanes (1:2) to provide 0.62g (83%) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester as a pale yellow solid. Electrospray Mass Spec: 344.4 (M-H)⁻

Step 4 To a solution of 3.31g (9.6mmol) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester and 2.12g (11.5mmol) of 5-(tetrahydro-2H-pyran-2-yloxy)-2-pentyn-1-ol in 15 mL of THF was added 3.0g (11.5 mmol) of triphenylphosphine, followed by dropwise addition of 1.8mL (11.5mmol) of diethyl azodicarboxylate. The resulting solution was stirred at room temperature for 18h. The reaction was diluted with ethyl acetate, washed with water and brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:9) to provide 3.03g (62%) of methyl 2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)-sulfonyl]-3-thiomorpholine carboxylate as a colorless oil. Electrospray Mass Spec: 534.4 (M+Na)⁺

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Step 5 A solution of 0.418g (0.817 mmol) of methyl 2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylate, 4.0 mL (4.08 mmol) of 1N NaOH, 4.0 mL of methanol and 4.0 mL of THF was heated to reflux for 5h. The reaction was concentrated and the residue was
5 diluted with water, acidified to pH5 and extracted with ethyl acetate. The organics were washed with water and brine, dried over MgSO₄, filtered and concentrated in vacuo to provide 0.342g (84%) of 2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylic acid as a colorless oil. Electrospray Mass Spec: 496.5 (M-H)⁺

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Step 6 To a solution of 0.28g (0.56 mmol) of 2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylic acid and 0.091g (0.675 mmol) of 1-hydroxybenzotriazole in 2.5mL of DMF was added 0.151g (0.788mmol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride and
15 stirred at room temperature for 1h. Then 0.173mL (2.8mmol) of 50% aqueous hydroxylamine was added and the reaction was stirred for 18h. The resulting mixture was diluted with ethyl acetate, washed with water, brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with 5% methanol/dichloromethane. The product was triturated with ether to provide
20 0.024g (8%) of N-hydroxy-2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide as a white solid. Electrospray Mass Spec: 513.4 (M+H)⁺

Example 244

25 **N-Hydroxy-4-({4-[(5-hydroxy-2-pentynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide**

To a solution of 0.33g (0.663 mmol) of 2,2-dimethyl-4-[(4-{[5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylic acid (Step 5, Example 243) and 0.108g (0.796 mmol) of 1-hydroxybenzotriazole in 3mL of
30 dichloromethane and 1 mL of DMF was added 0.169g (0.88 mmol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride and the reaction was stirred

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at room temperature for 1h. Then 0.203mL (3.31mmol) of 50% aqueous hydroxylamine was added and the reaction was stirred for 18h. The reaction was diluted with ethyl acetate, washed with water and brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was dissolved in 10mL of methanol and

5 0.028g (0.11mmol) of pyridinium p-toluenesulfonate was added and the reaction was heated to reflux for 18h. The reaction was concentrated in vacuo and the residue was chromatographed on silica gel eluting with 2.5% MeOH/CH₂Cl₂ to provide 0.59g (21%) of N-hydroxy-4-((4-[(5-hydroxy-2-pentynyl)oxy]phenyl)sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide as a white solid. Electrospray Mass Spec:

10 429.1 (M+H)⁺

Example 245

tert-Butyl 5-[4-((3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl)sulfonyl)phenoxy]-3-pentynylcarbamate

15 **Step 1** A mixture of 2.61 g (5.1 mmol) of methyl 2,2-dimethyl-4-[(4-[(5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl)oxy]phenyl)sulfonyl]-3-thiomorpholine carboxylate and 0.32g (1.275 mmol) of pyridinium p-toluene sulfonate in 50mL of methanol was heated to reflux for 18h. The reaction was concentrated in vacuo and the residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:4) to provide 2.2g

20 (100%) of methyl 4-((4-[(5-hydroxy-2-pentynyl)oxy]phenyl)sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide as a colorless oil. Electrospray Mass Spec: 428.1 (M+H)⁺

Step 2 To a solution of 2.123g (8.093 mmol) of triphenylphosphine and 0.373 mL (4.61 mmol) of pyridine in 40 mL of dry THF under nitrogen was added 1.73g (4.046

25 mmol) of methyl 4-((4-[(5-hydroxy-2-pentynyl)oxy]phenyl)sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide. The solution was cooled in a water bath and 1.34g (4.046 mmol) of carbon tetrabromide was added and the resulting mixture was stirred for 3h. The resulting suspension was filtered and the filtrate was concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl

30 acetate:hexanes (1:8) to provide 1.726g (87%) of methyl 4-((4-[(5-bromo-2-

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pentynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3- thiomorpholine carboxamide as a pale yellow oil. Electrospray Mass Spec: 492.0 (M+H)⁺

Step 3 A solution of 1.74g (3.55 mmol) of methyl 4-({4-[(5-bromo-2-pentynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3- thiomorpholine carboxamide and 0.277g (4.26 mmol) of sodium azide in 15 mL of DMF was stirred at room temperature for 18h. The reaction was diluted with ether, washed with water and brine, dried over MgSO₄, filtered and concentrated in vacuo to provide 1.6g (100%) of methyl 4-({4-[(5-azido-2-pentynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thio- morpholine carboxylate as a pale brown oil. Electrospray Mass Spec: 453.2 (M+H)⁺

Step 4 To a solution of 0.453g (1.0 mmol) of methyl 4-({4-[(5-azido-2-pentynyl)-oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate in 7 mL of ether and 1 mL of THF was dropwise added 0.275 mL (1.1 mmol) of tributylphosphine at room temperature. The reaction was stirred for 1h and then cooled to -50°C (acetonitrile/dry ice bath). A solution of 0.24g (1.1 mmol) of di-tert-butyldicarbonate in 3.5mL of ether was added and stirred at -50°C for 2h. Then 3.5mL of saturated solution of NaHCO₃ was added and the reaction was let warm to room temperature. The resulting mixture was diluted with ethyl acetate, washed with brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:6) to provide 0.21g (40%) of methyl-4-{{4-({5-[(tert-butoxycarbonyl)amino]-2-pentynyl}oxy)phenyl}sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylate as a colorless oil. Electrospray Mass Spec: 527.2 (M+H)⁺

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Step 5 According to the procedure of Step 5 of **Example 243**, 0.2g (0.38 mmol) of methyl-4-{{4-({5-[(tert-butoxycarbonyl)amino]-2-pentynyl}oxy)phenyl}sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylate provided 0.159g (82%) of 4-{{4-({5-[(tert-butoxycarbonyl)amino]-2-pentynyl}oxy)phenyl}sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylic acid as a colorless oil. Electrospray Mass Spec: 513.2 (M+H)⁺

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Step 6 According to the procedure of Step 6 of **Example 243**, 0.155g (0.3 mmol) of 4-{[4-({5-[(*tert*-butoxycarbonyl)amino]-2-pentynyl}oxy)phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid provided 0.058g (37%) of *tert*-butyl 5-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl)phenoxy]-3-pentynylcarbamate as a cream solid. Electrospray Mass Spec: 528.1 (M+H)⁺

Example 246

4-({4-[(5-Amino-2-pentynyl)oxy]phenyl)sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide

A solution of 0.071g (0.135 mmol) of *tert*-butyl 5-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl)phenoxy]-3-pentynylcarbamate from **Example 245**, 1 mL of trifluoroacetic acid and 3mL of dichloromethane was stirred for 1.5h. The solution was concentrated in vacuo and the residue was triturated with ether to provide 0.058g (79%) of 4-({4-[(5-amino-2-pentynyl)oxy]phenyl)sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide as a pale orange solid. Electrospray Mass Spec: 428.3 (M+H)⁺

Example 247

4-[(4-{[4-(Benzyloxy)-2-butynyl]oxy}phenyl)sulfonyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide

Step 1 To a suspension of 1.4g (34.0 mmol) of 60% sodium hydride in mineral oil in 40 mL of DMF was added 3.44g (40 mmol) of 2-butyne-1,4-diol and the reaction was stirred at room temperature for 3h. Then 4.04mL (34.0mmol) of benzyl bromide was added and the reaction was stirred for 18h. The reaction was quenched with water and extracted with ether. The organics were washed with brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:9) to provide 2.013g (34%) of the desired product, 4-(benzyloxy)-2-butyn-1-ol, as a colorless oil. CI Mass Spec: 159.1 (M-water+H)⁺ and 2.47g (27%) of 1-({[4-(benzyloxy)-2-butynyl]oxy}methyl)benzene as a colorless oil. EI Mass spec: 266.1 (M)⁺

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Step 2 According to the procedure of Step 4 of **Example 243**, Mitsunobu coupling of 0.345g (1.0mmol) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester and 0.211g (1.2mmol) of 4-(benzyloxy)-2-butyne-1-ol provided 0.211g (42%) of methyl 4-[(4-{[4-(benzyloxy)-2-butyne]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate as a pale yellow oil. Electrospray Mass Spec: 504.2 (M+H)⁺

Step 3 According to the procedure of Step 5 of **Example 243**, 0.2g (0.397mmol) of methyl 4-[(4-{[4-(benzyloxy)-2-butyne]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate provided 0.135g (65%) 4-[(4-{[4-(benzyloxy)-2-butyne]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate as white solid. Electrospray Mass Spec: 490.1 (M+H)⁺

Step 4 According to the procedure of Step 6 of **Example 243**, 0.12g (0.245mmol) of 4-[(4-{[4-(benzyloxy)-2-butyne]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate provided 0.03g (25%) of 4-[(4-{[4-(benzyloxy)-2-butyne]oxy}phenyl)sulfonyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide as a beige solid. Electrospray Mass Spec: 505.2 (M+H)⁺

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Example 248

N-Hydroxy-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide

Step 1 To a solution of 1.86mL (0.02 mol) of 4-pentyn-1-ol and 4.56 mL (0.05 mol) of 3,4-dihydro-2H-pyran in 60 mL of dichloromethane at 0°C was added 0.038g (0.2 mmol) of p-toluenesulfonic acid monohydrate. The reaction was stirred at room temperature for 2.5h, then washed with water, saturated solution of NaHCO₃, brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was kugelrohr distilled to provide 3.4g (100%) of the THP-ether of 4-pentyn-1-ol as a colorless liquid. According to the procedure of Step 1 of **Example 243**, 3.24g (19.26mmol) of

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this ether provided 3.51g (92%) of 6-(tetrahydro-2H-pyran-2-yloxy)-2-hexyn-1-ol as a pale yellow oil. CI Mass Spec: 199.2 (M+H)⁺

5 **Step 2** According to the procedure of Step 4 of Example 243, Mitsunobu coupling of 3.4g (9.842mmol) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester and 2.34g (11.81mmol) of 6-(tetrahydro-2H-pyran-2-yloxy)-2-hexyn-1-ol provided 3.33g (64%) of methyl-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylate as a colorless oil. Electrospray Mass Spec: 526.3 (M+H)⁺

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Step 3 According to the procedure of Step 5 of Example 243, 0.21g (0.4mmol) of methyl-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylate provided 0.163g (80%) of 2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylic acid as a pale yellow oil. Electrospray Mass Spec: 510.2 (M-H)⁻

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Step 4 According to the procedure of Step 6 of Example 243, 0.231g (0.45mmol) of 2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylic acid provided 0.082g (35%) of N-hydroxy-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide as a beige solid. Electrospray Mass Spec: 527.3 (M+H)⁺

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Example 249

25 **N-Hydroxy-4-({4-[(6-hydroxy-2-hexynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide**

According to the procedure of Step 1 of Example 245, 0.078g (0.15mmol) of N-hydroxy-2,2-dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide provided 0.048g (74%) of N-hydroxy-4-({4-[(6-hydroxy-2-hexynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide as a beige solid. Electrospray Mass Spec: 443.2 (M+H)⁺

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Example 250***tert*-Butyl 6-[4-(((3S)-3-[(hydroxyamino)carbonyl]-2,2-****dimethylthiomorpholinyl)sulfonyl)phenoxy]-4-hexynylcarbamate**

According to the procedures of Steps 1-4 of **Example 245**, methyl-2,2-
 5 dimethyl-4-[(4-{[6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl]oxy}phenyl)sulfonyl]-3-
 thiomorpholinecarboxylate (from **Example 248**) provided methyl-4-{[4-({6-[(*tert*-
 butoxycarbonyl)amino]-2-hexynyl}oxy)phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholin
 ecarboxylate as a colorless oil. Electrospray Mass Spec: 541.3 (M+H)⁺

A solution of 0.764g (1.41 mmol) of methyl-4-{[4-({6-[(*tert*-butoxycarbonyl)-
 10 amino]-2-hexynyl}oxy)phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate
 and 3.77g (28.2 mmol) of lithium iodide in 30 mL of ethyl acetate was heated to reflux
 for 18h. The resulting reaction was acidified, washed with water, an aqueous solution
 of Na₂S₂O₃, brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue
 was chromatographed on silica gel eluting with 0.5% methanol/dichloromethane to
 15 provide 0.417g (56%) of 4-{[4-({6-[(*tert*-butoxycarbonyl)amino]-2-hexynyl}oxy)-
 phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylic acid as a white solid.
 Electrospray Mass Spec: 527.2(M+H)⁺

According to the procedure of Step 6 of **Example 243**, 0.4g (0.76mmol) of 4-
 {[4-({6-[(*tert*-butoxycarbonyl)amino]-2-hexynyl}oxy)phenyl)sulfonyl}-2,2-dimethyl-3-
 20 thiomorpholinecarboxylic acid provided 0.162g (39%) of *tert*-butyl 6-[4-(((3S)-3-
 [(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl)sulfonyl)phenoxy]-4-hexynyl-
 carbamate as a cream solid. Electrospray Mass Spec: 541.9 (M+H)⁺

Example 251

25 **(3S)-4-({4-[(6-Amino-2-hexynyl)oxy]phenyl)sulfonyl}-N-hydroxy-2,2-dimethyl-3-
 thiomorpholine carboxamide**

Hydrogen chloride gas was bubbled into a solution of 0.104g (0.192 mmol) of
tert-butyl 6-[4-(((3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl)-
 sulfonyl)-phenoxy]-4-hexynylcarbamate in 6mL of dichloro-methane and 2 mL of
 30 methanol for 5min, and the reaction was stoppered and let stand for 1h and then
 concentrated in vacuo. The residue was triturated with ether to provide 0.092g

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(100%) of (3S)-4-({4-[(6-amino-2-hexynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide as a cream solid. Electrospray Mass Spec: 442.1 (M+H)⁺

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Example 252

***tert*-Butyl 7-[4-({(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-5-heptynylcarbamate**

According to the procedures of Steps 1 and 2 of **Example 248**, starting with 5-hexyn-1-ol, methyl 2,2-dimethyl-4-[(4-{[7-(tetrahydro-2H-pyran-2-yloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-3-thiomorpholine carboxylate was obtained as a pale yellow oil. Electrospray Mass Spec: 562.1 (M+Na)⁺

The tetrahydropyranyl ether of methyl 2,2-dimethyl-4-[(4-{[7-(tetrahydro-2H-pyran-2-yloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-3-thiomorpholinecarboxylate was removed according to the procedure of Step 1 of **Example 245** to give methyl 4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate as a colorless oil. Electrospray Mass Spec: 456.1 (M+H)⁺

According to the procedures of Steps 2-4 of **Example 245**, methyl 4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholinecarboxylate was converted into the corresponding BOC-protected carbamate, methyl (3S)-4-({4-[(7-[(*tert*-butoxycarbonyl)amino]-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate obtained as a colorless oil. Electrospray Mass Spec: 555.1 (M+H)⁺

The methyl ester of methyl (3S)-4-({4-[(7-[(*tert*-butoxycarbonyl)amino]-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate was converted into the analogous carboxylic acid using lithium iodide according to the procedure of **Example 250** to provide (3S)-4-({4-[(7-[(*tert*-butoxycarbonyl)amino]-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylic acid as a white solid. Electrospray Mass Spec: 541.2 (M+H)⁺

According to the procedure of Step 6 of **Example 243**, 0.315g (0.582mmol) of (3S)-4-({4-[(7-[(*tert*-butoxycarbonyl)amino]-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylic acid was converted into 0.113g (36%) of the

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corresponding hydroxamic acid, *tert*-butyl 7-[4-((3*S*)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl)sulfonyl]phenoxy]-5-heptynylcarbamate obtained as a white solid. Electrospray Mass Spec: 556.1 (M+H)⁺

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Example 253

(3*S*)-4-({4-[(7-Amino-2-heptynyl)oxy]phenyl}sulfonyl)-*N*-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide

According to the procedure of **Example 251**, 0.106g (0.19mmol) of *tert*-butyl 7-[4-((3*S*)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl)-sulfonyl]-phenoxy]-5-heptynylcarbamate provided 0.091g (98%) of (3*S*)-4-({4-[(7-amino-2-heptynyl)oxy]phenyl}sulfonyl)-*N*-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide as a cream solid. Electrospray Mass Spec: 456.2 (M+H)⁺

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Example 254

(3*S*)-*N*-Hydroxy-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine carboxamide

Step 1 According to the procedure of Step 2 of **Example 248**, Mitsunobu coupling of 0.345g (1.0mmol) of 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester and 0.159g (1.2mmol) of 3-phenyl-2-propyn-1-ol provided 0.254g (55%) of methyl (3*S*)-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine carboxylate as a pale yellow solid. Electrospray Mass Spec: 460.1 (M+H)⁺

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Step 2 According to the procedure of **Example 250**, lithium iodide mediated ester cleavage of 0.282g (0.61mmol) of methyl (3*S*)-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholinecarboxylate provided 0.215g (79%) of (3*S*)-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine carboxylic acid as a white solid. Electrospray Mass Spec: 446.0 (M+H)⁺

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Step 3 According to the procedure of **Example 9**, 0.195g (0.438mmol) of (3*S*)-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine-

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carboxylic acid provided 0.159g (79%) of (3S)-N-hydroxy-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine carboxamide as an off white solid. Electrospray Mass Spec: 460.9 (M+H)⁺

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Example 255

(3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1(S)-oxide

Example 266

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(3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1(R)-oxide

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To a 0°C solution of 2.40g (6.03 mmol) of the product of **Example 235**, (3S)-4-({4-(2-butynyloxy)phenyl}sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide, in 180 mL of dichloromethane and 36 mL of methanol was added 0.885g (5.126 mmol) of m-chloroperbenzoic acid in four equal portions, as a solid.

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Thirty minutes after all of the m-chloroperbenzoic acid had been added, the reaction was diluted with dichloromethane and washed with saturated sodium bicarbonate solution. The organics were dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with a gradient of chloroform/methanol (100:1) to (10:1) to provide 1.48g of a high R_f sulfoxide diastereomer and 0.22g of a low R_f sulfoxide diastereomer, both white solids, arbitrarily assigned as (3S)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1(S)-oxide and (3S)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1(R)-oxide respectively. Electrospray Mass Spec 415.3 (M+H)⁺

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Example 257

(3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1,1-dioxide

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To a 0° suspension of 0.200g (0.503 mmol) of the product of **Example 235**, (3S)-4-({4-(2-butynyloxy)phenyl}sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide, in 5 mL of chloroform was added 0.32 mL (1.508

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mmol) of a 32% solution of peracetic acid. The reaction became homogeneous and was allowed to warm to room temperature and stirred for an additional 3h. An additional 0.3mL of 32% peracetic acid was added and the reaction was stirred overnight at room temperature and then concentrated in vacuo. The residue was
5 diluted with ethyl acetate and the organics were washed with water and saturated sodium bicarbonate solution, dried over sodium sulfate, filtered and concentrated. The residue was chromatographed on silica gel eluting with chloroform/methanol (100:1) to provide 0.138g of (3S)-4-{{4-(2-butyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1,1-dioxide as a brown solid. Electrospray
10 Mass Spec 431.3 (M+H)+

Example 258

(3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2-propyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide

15 **Step 1** To a 0° suspension of 14.92g (0.10 mmol) of D-penicillamine in 300 mL of dichloroethane and 2.0 mL of DMF was added 22.4 mL of DBU followed by 19.0 mL of trimethylsilyl chloride. The ice bath was removed and the reaction was stirred for 3h, after which an additional 29.9 mL of DBU was added. The reaction was stirred overnight at room temperature and then 10 mL of methanol was added and the
20 reaction was stirred for 1h. The resulting white precipitate was filtered off, washed with 10 mL of methanol and dried in vacuo to provide 16g of (3S)-2,2-dimethyl-3-thiomorpholine carboxylic acid as a white solid.

Step 2 To a 0° suspension of 32g (0.18 mol) of the above carboxylic acid in 365 mL of dioxane was added 36.6 mL of concentrated sulfuric acid over 10 minutes followed by 225 mL of isobutylene. The reaction was warmed to room temperature and stirred for 15h with a dry ice/acetone condenser. The reaction was then poured into a mixture of 1L of 2M sodium bicarbonate solution and 400mL of ethyl acetate. The organics were dried over sodium sulfate, filtered and concentrated to give 22g of *tert*-butyl
25 (3S)-2,2-dimethyl-3-thiomorpholine carboxylate as a white solid. Electrospray Mass
30 Spec 232.3 (M+H)+

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Step 3 To a suspension of 20.0g (0.104 mol) of 4-hydroxybenzenesulfonyl chloride in 200 mL of chloroform was added 28.25 mL (0.114 mol) of bis(trimethylsilyl)-acetamide and the reaction was stirred at room temperature for 1h, after which all of the solids have dissolved. To this mixture was added 20.0g (0.087 mol) of *tert*-butyl (3S)-2,2-dimethyl-3-thiomorpholine carboxylate followed by 19.2 mL of 4-methylmorpholine and the reaction was stirred overnight at room temperature. After the addition of 400 mL of methanol to the reaction, the resulting mixture was stirred overnight at room temperature and then concentrated in vacuo. The residue was diluted with ethyl acetate and the organics were washed with water and 5% HCl solution, dried over magnesium sulfate, filtered and concentrated in vacuo. The resulting white solid was washed with ether/hexanes (1:2) and dried in vacuo to give 28.4g (85%) of *tert*-butyl (3S)-4-[(4-hydroxyphenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate as a white solid. Electrospray Mass Spec 386.5 (M-H)-.

15

Step 4 According to the procedure of Step 2 of **Example 248**, Mitsunobu coupling of 0.30g (0.775 mmol) of *tert*-butyl (3S)-4-[(4-hydroxyphenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate and 0.054 mL (0.93 mmol) of propargyl alcohol gave 0.313g of *tert*-butyl (3S)-2,2-dimethyl-4-{[4-(2-propynyloxy)phenyl]sulfonyl}-3-thiomorpholine carboxylate as a white solid. Electrospray Mass Spec 426.4 (M+H)+

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Step 5 Through a solution of 0.271g (0.638 mmol) of *tert*-butyl (3S)-2,2-dimethyl-4-{[4-(2-propynyloxy)phenyl]sulfonyl}-3-thiomorpholinecarboxylate in 10 mL of dichloromethane was bubbled hydrogen chloride gas for 10 minutes. The reaction was then stoppered and let sit overnight at room temperature. The solvent was evaporated to give 0.221g of (3S)-2,2-dimethyl-4-{[4-(2-propynyloxy)phenyl]sulfonyl}-3-thiomorpholine carboxylic acid as a white solid. Electrospray Mass Spec 368.2 (M-H)-

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Step 6 According to the procedure of **Example 9**, 0.196 g (0.531 mmol) of (3S)-2,2-dimethyl-4-{[4-(2-propynyloxy)phenyl]sulfonyl}-3-thiomorpholinecarboxylic acid gave 0.192g of the hydroxamic acid, (3S)-N-hydroxy-2,2-dimethyl-4-{[4-(2-propynyl-

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oxy)phenyl]sulfonyl}-3-thiomorpholine carboxamide as a white solid. Electrospray Mass Spec 385.1 (M+H)+

Example 259

5 **(3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2-pentynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide**

According to the procedure of **Example 258**, using 2-pentyn-1-ol in Step 4, (3S)-N-hydroxy-2,2-dimethyl-4-{{4-(2-pentynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide was obtained as a white solid. Electrospray Mass Spec 413.2 (M+H)+

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Example 260

(3S)-N-Hydroxy-4-({4-[(4-hydroxy-2-butyryl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide

15 **Step 1** According to the procedure of Step 2 of **Example 248**, Mitsunobu coupling of 2.5g (6.46 mmol) of *tert*-butyl (3S)-4-[(4-hydroxyphenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate and 0.667g (7.752 mmol) of 2-butyne-1,4-diol gave 1.42g of *tert*-butyl (3S)-4-({4-[(4-hydroxy-2-butyryl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate as a colorless oil.

20

Step 2 The alcohol (0.300g, 0.662 mmol) was dissolved in 3 mL of acetic anhydride and 0.3 mL of pyridine. The reaction was stirred overnight at room temperature and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to provide 0.279g (85%) of *tert*-butyl(3S)-4-[(4-{{4-(acetyloxy)-2-butyryl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate as a colorless oil. Electrospray Mass Spec 498.1 (M+H)+

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Step 3 Through a solution of 0.250g (0.503 mmol) of *tert*-butyl(3S)-4-[(4-{{4-(acetyloxy)-2-butyryl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate in 10 mL of dichloromethane was bubbled hydrogen chloride gas for 10 minutes. The reaction was then stoppered and let sit overnight at room temperature. The solvent

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was evaporated to give 0.192g of (3S)-4-[(4-{[4-(acetyloxy)-2-butynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylic acid as a colorless oil. Electrospray Mass Spec 440.1 (M-H)-

- 5 **Step 4** According to the procedure of **Example 9**, 0.150g (0.340 mmol) of (3S)-4-[(4-{[4-(acetyloxy)-2-butynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylic acid gave 0.127g of the hydroxamic acid, (3S)-N-hydroxy-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide as a white solid. Electrospray Mass Spec 415.2 (M+H)+

10

Example 261

4-[4-((3S)-3-[(Hydroxyamino)carbonyl]-2,2-

dimethylthiomorpholinyl)sulfonyl]phenoxy]-2-butynyl acetate

- According to the procedure of **Example 25**, 0.196g (0.444 mmol) of (3S)-4-
15 [(4-{[4-(acetyloxy)-2-butynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylic acid from Step 3 of **Example 260** gave 0.086g of 4-[4-((3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl)sulfonyl]phenoxy]-2-butynyl acetate as a tan amorphous solid. Electrospray Mass Spec 457.1 (M+H)+

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Example 262

(3S)-N-Hydroxy-4-({4-[(6-hydroxy-2,4-hexadiynyl)oxy]phenyl}sulfonyl)-2,2-
dimethyl-3-thiomorpholine carboxamide

- According to the procedures for **Example 260**, using 2,4-hexadiyn-1,6-diol in
Step 1, (3S)-N-hydroxy-4-({4-[(6-hydroxy-2,4-hexadiynyl)oxy]phenyl}sulfonyl)-2,2-
25 dimethyl-3-thiomorpholine carboxamide was obtained as a tan solid. Electrospray Mass Spec 439.1 (M+H)+

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Example 263**(3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2,4-pentadiynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide**

According to the procedures of Steps 4-6 of **Example 258**, using 2,4-pentadiyn-1-ol (EP 478,195) in Step 4, (3S)-N-hydroxy-2,2-dimethyl-4-{{4-(2,4-pentadiynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide was obtained as a white solid. Electrospray Mass Spec 408.9 (M+H)+

Example 264**(3S)-4-({4-[(4-Fluoro-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide**

To a 0° solution of 0.300g (0.659 mmol) of *tert*-butyl (3S)-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate from Step 1 of **Example 260** in 75 mL of dichloromethane was added 0.17 mL of (diethyl-amino)sulfur trifluoride and the reaction was stirred overnight at room temperature. The reaction was quenched with brine and the organic layer was separated and dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to give the propargylic fluoride as a brown oil. Electrospray Mass Spec 457.8 (M+H)+

According to the procedures of Steps 3 and 4 of **Example 260** the *tert*-butyl ester was hydrolyzed to the carboxylic acid and then converted into the hydroxamic acid, (3S)-4-({4-[(4-fluoro-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide obtained as a light brown solid. Electrospray Mass Spec 417.3 (M+H)+

Example 265**4-({4-[(4-Amino-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide**

Step 1 According to the procedure of Step 2 of **Example 248**, Mitsunobu coupling of 0.10g (0.288 mmol) of methyl (3S)-4-[(4-hydroxyphenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate and 0.031g (0.363 mmol) of 2-butyne-1,4-diol gave 0.078g

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of methyl (3S)-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate as a colorless oil.

Step 2 To a solution of 1.59g (3.85 mmol) of methyl (3S)-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate in 50 mL of dichloromethane was added 1.34 mL (9.63 mmol) of triethylamine followed by 0.36 mL (4.62 mmol) of methanesulfonyl chloride. The reaction was stirred at room temperature for 3h and then diluted with ether. The organics were washed with 5% HCl solution and water, dried over magnesium sulfate, filtered and concentrated. The residue was used in the next step without purification.

Step 3 To a solution of the above mesylate (1.06g, 2.16 mmol) in 12 mL of DMF was added 0.168g (2.59 mmol) of sodium azide. The reaction was stirred at room temperature for 12h and then diluted with ethyl acetate. The organics were washed with water, dried over magnesium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.823g of the azide, methyl (3S)-4-({4-[(4-azido-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate.

Step 4 To a solution of 0.811g (1.852 mmol) of the azide in 13mL of ether and 3.5mL of THF was added 0.692mL (2.777 mmol) of tributylphosphine and the reaction was stirred for 4h. The reaction was then cooled to -40°C and a solution of 0.647g (2.962 mmol) of di-*tert*-butyl dicarbonate in 9mL of ether was added dropwise. The reaction was stirred at -40°C for 1h and then saturated sodium bicarbonate solution was added (10mL) and the reaction was warmed to room temperature and stirred overnight. The organics were washed with water, dried over magnesium sulfate, filtered and concentrated. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 0.301g of the NH-carbamate methyl ester, methyl 4-({4-[(*tert*-butoxycarbonyl)amino]-2-butynyl}oxy)phenyl)sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxylate.

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Step 5 According to the procedure of **Example 11** 0.300g (0.586 mmol) of the NH-carbamate methyl ester gave 0.149g of the NH-carbamate carboxylic acid, 4-{{4-[(tert-butoxycarbonyl)amino]-2-butynyl}oxy}phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylic acid which was subsequently converted into 0.057g of the hydroxamic acid following the procedure of **Example 25**. Bubbling hydrogen chloride gas through a dichloromethane solution of the NH-carbamate hydroxamic acid then provided 0.057g of 4-{{4-[(4-amino-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide hydrochloride. Electrospray Mass Spec 414.4 (M+H)+

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Example 266

tert-Butyl 4-[4-{{3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl}phenoxy]-2-butynylcarbamate

According to the procedure of **Example 25**, 0.106g (0.213 mmol) of 4-{{4-[(tert-butoxycarbonyl)amino]-2-butynyl}oxy}phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylic acid provided 0.052g of *tert*-butyl 4-[4-{{3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl}phenoxy]-2-butynylcarbamate as a white solid. Electrospray Mass Spec 514.1 (M+H)+

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Example 267

tert-butyl 4-[4-{{3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl}phenoxy]-2-butynyl(methyl)carbamate

Step 1 To a solution of 2.714g (0.01 mol) of triphenylphosphine in 21mL of THF and 0.41mL of pyridine was added 2.137g (5.174 mmol) of methyl (3S)-4-{{4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl}-2,2-dimethyl-3-thiomorpholine carboxylate (from Step 1 of **Example 265**) followed by 1.716g (5.174 mmol) of carbon tetrabromide. The reaction was stirred at room temperature for 4h and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:3) to give 1.523g (62%) of the propargylic bromide.

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Step 2 To a solution of 0.50g (1.050 mmol) of the propargylic bromide in 5mL of THF was added 5.25mL (0.010 mmol) of a 2.0M solution of methylamine in THF followed by 0.020g of tetrabutylammonium iodide. The reaction was stirred at room temperature for 4h and then diluted with ether. The organics were washed with water, dried over sodium sulfate, filtered and concentrated. The residue chromatographed on silica gel eluting first with ethyl acetate then with chloroform/methanol (9:1) to give 0.365g (82%) of the methylamine, methyl 2,2-dimethyl-4-[(4-{[4-(methylamino)-2-butynyl]oxy}phenyl)sulfonyl]-3-thiomorpholinecarboxylate as a colorless oil.

Electrospray Mass Spec 427.3 (M+H)+

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Step 3 To a solution of 0.331g (0.777 mmol) of methyl 2,2-dimethyl-4-[(4-{[4-(methylamino)-2-butynyl]oxy}phenyl)sulfonyl]-3-thiomorpholinecarboxylate in 5mL of THF was added 9mg of 4-dimethylaminopyridine followed by 0.186g (0.855 mmol) of di-tert-butyl dicarbonate. The reaction was stirred for 4h and then concentrated in vacuo. The residue chromatographed on silica gel eluting first with ethyl acetate/hexanes (1:10) to (1:3) to give 0.344g of methyl 4-{[4-((tert-butoxycarbonyl)(methyl)amino)-2-butynyl]oxy}phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate as a pale yellow oil. Electrospray Mass Spec 527.6 (M+H)+

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Step 4 According to the procedures of **Example 11** and **Example 25**, 0.312g (0.593 mmol) of methyl 4-{[4-((tert-butoxycarbonyl)(methyl)amino)-2-butynyl]oxy}phenyl)sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate was converted into 0.049g of the hydroxamic acid, *tert*-butyl 4-[4-((3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl)sulfonyl)phenoxy]-2-butynyl(methyl)carbamate obtained as a white solid. Electrospray Mass Spec 528.1 (M+H)+

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Example 268

7-[4-((3S)-3-[(Hydroxyamino)carbonyl]-2,2-

dimethylthiomorpholinyl)sulfonyl)phenoxy]-5-heptynyl acetate

Step 1 According to the procedures of Step 1 of **Example 248**, starting with 5-hexyn-1-ol provided 6-(tetrahydro-2H-pyran-2-yloxy)-2-heptyn-1-ol.

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According to the procedure of Step 4 of **Example 243**, Mitsunobu coupling of 0.775g (2.0mmol) of *tert*-butyl (3S)-4-[(4-hydroxyphenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine carboxylate (Step 3, Example 258) and 0.510g (2.4mmol) of 6-(tetrahydro-2H-pyran-2-yloxy)-2-heptyn-1-ol provided 0.975g (84%) of *tert*-butyl (3S)-2,2-dimethyl-4-[(4-{[7-(tetrahydro-2H-pyran-2-yloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-3-thiomorpholinecarboxylate as a colorless oil. Electrospray Mass Spec: 604.2 (M+Na)⁺

Step 2 According to the procedure of Step 1 of **Example 245** the tetrahydropyranyl ether of 0.659g (1.13 mmol) of *tert*-butyl (3S)-2,2-dimethyl-4-[(4-{[7-(tetrahydro-2H-pyran-2-yloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-3-thiomorpholinecarboxylate was cleaved to provide 0.472g (84%) of *tert*-butyl (3S)-4-[(4-{[7-(7-hydroxy-2-heptynyl)oxy]phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate as a colorless oil. Electrospray Mass Spec: 498.3 (M+H)⁺

Step 3 A mixture of 0.452g (0.908 mmol) of *tert*-butyl (3S)-4-[(4-{[7-(7-hydroxy-2-heptynyl)oxy]phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate, 2.6mL (27 mmol) of acetic anhydride and 0.22mL (2.7 mmol) of pyridine was stirred at room temperature for 6h and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:5) to provide 0.476g (97%) of *tert*-butyl (3S)-4-[(4-{[7-(acetyloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate as a colorless oil. Electrospray Mass Spec: 540.0 (M+H)⁺

Step 4 According to the procedure of **Example 251**, lithium iodide mediated ester cleavage of 0.456g (0.845mmol) of *tert*-butyl (3S)-4-[(4-{[7-(acetyloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylate provided 0.409 g (100%) of (3S)-4-[(4-{[7-(acetyloxy)-2-heptynyl]oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholinecarboxylic acid as a colorless oil. Electrospray Mass Spec: 446.0 (M+H)⁺

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Step 5 According to the procedure of **Example 9**, 0.192g (0.398 mmol) of (3S)-4-[[4-{{7-(acetyloxy)-2-heptynyl}oxy}phenyl)sulfonyl]-2,2-dimethyl-3-thiomorpholine-carboxylic acid provided 0.125g (63%) of 7-[4-{{(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl}phenoxy]-5-heptynyl acetate as a white solid.

5 Electrospray Mass Spec: 499.0 (M+H)⁺

Example 269

(3S)-N-Hydroxy-4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3- thiomorpholinecarboxamide

10 A mixture of 0.152g (0.305 mmol) of 7-[4-{{(3S)-3-[(hydroxyamino)-carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl}phenoxy]-5-heptynyl acetate, 3mL of aqueous ammonium hydroxide and 3mL of methanol was stirred at room temperature for 18h and concentrated in vacuo. The residue was chromatographed on silica gel eluting with 1.5% methanol/dichloromethane to provide 0.09g (65%) of (3S)-N-
15 hydroxy-4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholinecarboxamide as a white solid. Electrospray Mass Spec: 457.0 (M+H)⁺

Example 270

(3S,5S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide

20 **Step 1** To a stirred solution of 0.445g (2.4 mmol) of 75% 1-bromo-2-propanol in 2 mL of DMF was added a solution of 0.4g (2.0 mmol) of D-penicillamine hydrochloride and 0.6mL (4.0mmol) of 1,8 diazabicyclo[5.4.0]undec-7-ene in 4.0mL of DMF over 15 minutes. The reaction was stirred for 3h and 0.489g (2.0 mmol) of 4-
25 but-2-ynyloxybenzenesulfonyl chloride and 0.3mL (2.0mmol) of 1,8-diazabicyclo-[5.4.0]undec-7-ene were added. The reaction was stirred for 18h and diluted with ethyl acetate. The organics were washed with water and brine, dried over MgSO₄, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate:hexanes (1:5) to provide 0.248g (29%) of the hydroxy-acid
30 sulfonamide as a colorless oil. Electrospray Mass Spec: 430.0 (M+H)⁺

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Step 2 To a solution of 0.07g (0.163 mmol) of the above hydroxy-acid sulfonamide in 1.6mL of THF was added 0.051g (0.195 mmol) of triphenylphosphine, followed by 0.031mL (0.195 mmol) of diethylazodicarboxylate. The reaction was stirred at room temperature for 18h and diluted with ethyl acetate. The organics were washed with water and brine, dried over MgSO_4 , filtered and concentrated in vacuo. The residue was chromatographed by preparative TLC eluting three times with ethyl acetate/hexanes (1:5) to provide 0.027g (39%) of methyl (3S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholinecarboxylate as a colorless oil [Electrospray Mass Spec: 412.2 (M+H)⁺] and 0.021g (31%) of methyl (3S,5R)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholine-carboxylate as a colorless oil [Electrospray Mass Spec: 412.2 (M+H)⁺]

Step 3 Lithium iodide mediated ester cleavage of 0.384g (0.933mmol) of methyl (3S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholine-carboxylate according to the procedure of **Example 250**, provided 0.356g (96%) of (3S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholine-carboxylic acid as a white solid. Electrospray Mass Spec: 397.9 (M+H)⁺

Step 4 According to the procedure of **Example 9**, 0.330g (0.829mmol) of (3S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholinecarboxylic acid provided 0.23g (67%) of (3S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide as a white solid. Electrospray Mass Spec: 413.0 (M+H)⁺

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Example 271

(3S,5R)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide

Step 1 Lithium iodide mediated ester cleavage of 0.335g (0.814mmol) of methyl (3S,5R)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholine-carboxylate according to the procedure of **Example 250**, provided 0.305g (94%) of

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(3S,5R)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholine-carboxylic acid as a white solid. Electrospray Mass Spec: 398.0 (M+H)⁺

5 **Step 2** According to the procedure of **Example 9**, 0.28g (0.707 mmol) of (3S,5R)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,5-trimethyl-3-thiomorpholinecarboxylic acid provided 0.16g (55%) of (3S,5R)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide as a white solid. Electrospray Mass Spec: 413.2 (M+H)⁺

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Example 272

(3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,6-trimethyl-3-thiomorpholinecarboxamide

Step 1 To a solution of 1.47g (4.53 mmol) of 3,3'-dithiobis[D-valine], dimethyl ester bis hydrochloride in 25 mL of methylene chloride at 0° was added 2.5 mL (18.1 mmol) of triethylamine followed by 2.77g (11.3 mmol) of 4-but-2-ynyloxy-benzenesulfonyl chloride, portionwise. The reaction was stirred at room temperature for 22h and then reduced to dryness. To the resulting residue was added ethyl acetate which was washed with 1M HCl, water and brine. The organic layer was dried over sodium sulfate, filtered, reduced to dryness and chromatographed on silica gel eluting with ethyl acetate (2:1) to provide 1.97g (59%) of the disulfonamide, 3,3'-dithiobis[N-[[4-(2-butynyloxy)phenyl]sulfonyl]-D-valine] dimethyl ester as a white powder. Electrospray Mass Spec: 741.0 (M+H)⁺

25 **Step 2** To a mixture of 3.474g (4.70 mmol) of 3,3'-dithiobis[N-[[4-(2-butynyloxy)-phenyl]sulfonyl]-D-valine] dimethyl ester, 6.5g (46.95 mmol) of potassium carbonate and 30 mL of DMF cooled to 0° was added dropwise 4.06mL (46.95 mmol) of allyl bromide. After stirring overnight at room temperature the mixture was diluted with ethyl acetate and subsequently was washed with water and brine. The organic layer was dried over sodium sulfate, filtered and reduced to dryness. The residue was chromatographed on silica gel eluting with ethyl acetate (3:1) to provide 2.97g (77%)

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of 3,3'-dithiobis[N-allyl-N-[[4-(2-butynyloxy)phenyl]sulfonyl]-D-valine] dimethyl ester as white foam. Electrospray Mass Spec: 821.0 (M+H)+

Step 3 To a solution of 0.7124g (0.869 mmol) of 3,3'-dithiobis[N-allyl-N-[[4-(2-butynyloxy)phenyl]sulfonyl]-D-valine] dimethyl ester in 10 mL of THF was added 0.2 mL of water and 3.26mL (13.04 mmol) of tributylphosphine. This mixture was heated at reflux for 20h, concentrated in vacuo, dissolved in ethyl acetate, washed with 1M citric acid and brine. The organic layer was dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate (4:1) to provide 0.36g (50%) of the thiol, methyl (2S)-2-(allyl{[4-(2-butynyloxy)phenyl]sulfonyl}amino)-3-methyl-3-sulfanylbutanoate as yellow oil. Electrospray Mass Spec: 412.2 (M+H)+

Step 4 To a solution of 0.4262g (1.037 mmol) of methyl (2S)-2-(allyl{[4-(2-butynyloxy)phenyl]sulfonyl}amino)-3-methyl-3-sulfanylbutanoate in 20 mL of cyclohexane was added 50 mg of benzoyl peroxide. The resulting solution was heated at reflux for 3h. After cooling to room temperature and concentrating in vacuo the residue was chromatographed on silica gel eluting with ethyl acetate (4:1) to provide 0.222g (52%) of a 60:40 mixture of C-6 thiomorpholine diastereomers, methyl (3S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,6-trimethyl-3-thiomorpholinecarboxylate, as clear oil. Electrospray Mass Spec: 412.2 (M+H)+

Step 5 To a solution of 0.1079g (0.2625 mmol) of methyl (3S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,6-trimethyl-3-thiomorpholinecarboxylate in 2mL of THF and 2 mL of methanol was added 1.31 mL (1.31 mmol) of 1M sodium hydroxide. The resulting solution was heated at reflux for 6h. After cooling to room temperature the pH was adjusted to 3-4 by addition of 1N HCl. The mixture was extracted 3 times with a total of 150 ml of chloroform. The combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo to provide 0.096g (92%) of the carboxylic acid, (3S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,6-trimethyl-3-thiomorpholinecarboxylic acid, as a white powder.

Electrospray Mass Spec: 396.2 (M-H)-

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Step 6 According to the procedure of **Example 25**, 0.25g (0.63 mmol) of (3S)-4-
{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,6-trimethyl-3-thiomorpholinecarboxylic acid
furnished 0.114g (44%) of the hydroxamic acid, (3S,6S)-4-{[4-(2-butynyloxy)phenyl]-
5 sulfonyl}-N-hydroxy-2,2,6-trimethyl-3-thiomorpholinecarboxamide, as a white
powder. Electrospray Mass Spec: 413.1 (M+H)+

Example 273

**tert-Butyl{(2R,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-
10 [(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl)methylcarbamate**

Step 1 To a solution of 8.164g (9.96 mmol) of 3,3'-dithiobis[N-allyl-N-[[4-(2-butynyl-
oxy)-phenyl]sulfonyl]-D-valine] dimethyl ester (from **Example 272**) in 300mL of
methylene chloride at 0° was added a solution of 0.51 mL (9.9 mmol) of bromine in 25
mL of dichloromethane dropwise with the exclusion of light. The resulting solution
15 was stirred overnight and was then washed with saturated aqueous sodium thiosulfate
and brine. The organic layer was dried over sodium sulfate, filtered and concentrated
in vacuo. Flash chromatography of the resulting residue on silica gel eluting with ethyl
acetate (4:1) provided 7.03g (72%) of a 2:1 mixture of bromide diastereomers, methyl
(3S)-6-(bromomethyl)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thio-
20 morpholinecarboxylate, as a white foam. Electrospray Mass Spec: 490.0 & 492.0
(M+H)+

Step 2 To a solution of 16.45g (0.0336 mmol) of methyl (3S)-6-(bromomethyl)-4-{[4-
(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate in 200 mL
25 of DMSO was added 21.87g (0.336 mol) of sodium azide. The resulting mixture was
heated at 60° for 4.5h, cooled to room temperature, diluted with 1L of water and
twice extracted with 1L of ether. The organic layer was dried over sodium sulfate,
filtered, reduced to dryness and chromatographed on silica gel eluting with ethyl
acetate (4:1) to provide 13.35g (88%) of a 2:1 diastereomeric mixture of azides,
30 methyl (3S)-6-(azidomethyl)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-
thiomorpholinecarboxylate as a white foam. . Electrospray Mass Spec: 453.1 (M+H)+

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Step 3 To a solution of 13.168g (0.0291mol) of methyl (3S)-6-(azidomethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate in 200mL of ether was added 8.0 mL (0.03201 mol) of tributylphosphine dropwise over 0.5h. The solution was stirred overnight, cooled to -50° and then treated with a solution of 6.99g (0.032 mol) of di-*t*-butyldicarbonate in 30mL of ether dropwise over 0.5h. After 1.5h 50 mL of saturated aqueous sodium bicarbonate was added and the cooling bath was removed. The resulting mixture was twice extracted with 300 mL of ethyl acetate. Combined organic layers were dried over sodium sulfate, filtered, concentrated in vacuo and chromatographed on silica gel eluting with hexanes/ ethyl acetate (4:1) to provide 9.91g (65%) of a 2:1 mixture of carbamates. These diastereomers could be separated by careful iterative gradient flash chromatography eluting with hexanes/ ethyl acetate (20:1)-(3:1). The less polar diastereomer (methyl (3S,6R)-6-{{{tert-butoxycarbonyl}amino}methyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate, Electrospray Mass Spec: 527.2 (M+H)+) was eluted first closely followed by (methyl (3S,6S)-6-{{{tert-butoxycarbonyl}amino}methyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate, Electrospray Mass Spec: 527.1 (M+H)+).

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Step 4 To a solution of 3.24g (6.16 mmol) of methyl (3S,6R)-6-{{{tert-butoxycarbonyl}amino}methyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate in 50 mL of ethyl acetate was added 11g (82.2 mmol) of lithium iodide. The resulting mixture was heated at reflux for 14h, cooled to room temperature and 10 mL of water was added. The aqueous layer was acidified to pH 3-4 with 1M HCl and back extracted with ethyl acetate. Combined organic layers were washed with water, brine, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with dichloromethane/ methanol 10:1 furnishing 2.45g (78%) of the desired carboxylic acid, (3S,6R)-6-{{{tert-butoxycarbonyl}amino}methyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-

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dimethyl-3-thiomorpholinecarboxylic acid, as a white foam. Electrospray Mass Spec: 513.3 (M+H)+

- Step 5** According to the procedure of **Example 25**, 2.42g (4.73 mmol) of (3S,6R)-6-
5 [[(tert-butoxycarbonyl)amino]methyl]-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-
dimethyl-3-thiomorpholinecarboxylic acid furnished 0.796g (32%) of the hydroxamic
acid, *tert*-butyl{(2R,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)-
carbonyl]-6,6-dimethylthiomorpholinyl)methylcarbamate, as a white foam following
chromatography on silica gel eluting with dichloromethane/methanol (10:1).
10 Electrospray Mass Spec: 528.3 (M+H)+

Example 274

tert-Butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-
[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl)methylcarbamate

- 15 **Step 1** According to the procedure of Step 4 of **Example 273** lithium iodide mediated
ester cleavage of 0.83g (1.58 mmol) of methyl (3S,6S)-6-{[(*tert*-butoxycarbonyl)-
amino]methyl}-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholine-
carboxylate (Step 3 of **Example 273**) furnished 0.641g (79%) of the carboxylic acid,
(3S,6S)-6-{[(*tert*-butoxycarbonyl)amino]methyl}-4-{[4-(2-butynyloxy)phenyl]-
20 sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid, as a white foam. Electrospray
Mass Spec 513.2: (M+H)+

- Step 2** According to the procedure of **Example 25**, 0.639g (1.25 mmol) of (3S,6S)-6-
{[(*tert*-butoxycarbonyl)amino]methyl}-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-
25 dimethyl-3-thiomorpholinecarboxylic acid furnished 0.359g (54%) of the hydroxamic
acid, *tert*-butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)-
carbonyl]-6,6-dimethylthiomorpholinyl)methylcarbamate, as a white foam following
chromatography on silica gel eluting with dichloromethane/methanol (10:1).
Electrospray Mass Spec: 528.3 (M+H)+

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Example 275

(3S,6R)-Trans-6-(aminomethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride

Through a solution of 0.796g (1.51 mmol) of *tert*-butyl{(2R,5S)-4-
5 { [4-(2-butynyloxy)phenyl]sulfonyl }-5-[(hydroxyamino)carbonyl]-6,6-dimethyl-thio-
morpholinyl}methylcarbamate (**Example 273**) in 30 mL of dichloromethane cooled to
0° was bubbled hydrogen chloride gas for 3 minutes. The flask was sealed and stirred
at room temperature for 1h. The resulting mixture was concentrated in vacuo to
provide 0.674g (96%) of (3S,6R)-trans-6-(aminomethyl)-4-{{[4-(2-butynyloxy)-
10 phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide
hydrochloride as a brown solid. Electrospray Mass Spec 428.3: (M+H)+

Example 276

**(3S,6S)-Cis-6-(aminomethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-
15 2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride**

According to the procedure of **Example 275**, 0.41g (0.778 mmol) of the
product of **Example 274** furnished 0.34g (94%) of (3S,6S)-cis-6-(aminomethyl)-
4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine-
carboxamide hydrochloride as a brown solid. Electrospray Mass Spec: 428.1 (M+H)+
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Example 277

***tert*-Butyl{(2S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-
[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl}acetate**

Step 1 To a solution of 21.1g (0.0285 mol) of 3,3'-dithiobis[N-[[4-(2-butynyloxy)-
25 phenyl]sulfonyl]-D-valine] dimethyl ester (**Step 1, Example 272**) in 200mL of DMF
was added 11.8g (0.0855 mol) potassium carbonate followed by a solution of 18.9g
(0.0855 mol) *tert*-butyl (E)-4-bromo-2-butenolate in 30 mL of DMF dropwise. The
resulting mixture was stirred overnight, diluted with 1L of water and twice extracted
with a total of 1L of ether. Combined organic extracts were washed with brine, dried
30 over sodium sulfate, filtered and concentrated in vacuo. The residue was
chromatographed on silica gel eluting with ethyl acetate (4:1) to provide 22.87 (79%)

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of 18-(*tert*-butyl)-9,14-dimethyl(5E,9S,14S,17E)-8,15-bis{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,10,10,13,13-hexamethyl-4-oxo-3-oxa-11,12-dithia-8,15-diazaoctadeca-5,17-diene-9,14,18-tricarboxylate as a brown oil. Electrospray Mass Spec: 1021.0 (M+H)+

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Step 2 To a solution of 22.87g (0.02241 mol) of 18-(*tert*-butyl)-9,14-dimethyl(5E,9S,14S,17E)-8,15-bis{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2,10,10,13,13-hexamethyl-4-oxo-3-oxa-11,12-dithia-8,15-diazaoctadeca-5,17-diene-9,14,18-tricarboxylate in 300mL of THF was added 30mL of water and 90 mL (0.2241 mol) of tributylphosphine. The resulting mixture was heated at reflux overnight, cooled to room temperature and concentrated in vacuo. The residue was dissolved in ethyl acetate, washed with 1M citric acid, brine, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate (4:1) to provide 17.63g (77%) of the thiomorpholine, methyl (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate, as a brown oil. Electrospray Mass Spec: 512.2 (M+H)+

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Step 3 To a solution of 2.273g (4.45 mmol) of methyl (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate in 30 mL of ethyl acetate was added 2.98g (22.2 mmol) of lithium iodide. This mixture was heated at reflux for 20h and then was cooled to room temperature. Water (100 mL) was added and the aqueous layer was acidified to pH 3-4 with 1M HCl. The mixture was back extracted twice with 200 mL of ethyl acetate. The combined organic layers were washed with water, saturated aqueous sodium thiosulfate and then brine. Sodium sulfate was added to dry the organic layer which was subsequently filtered, concentrated in vacuo and chromatographed on silica gel eluting with dichloromethane/methanol (10:1) to furnish 1.535g (69%) of the mono acid, (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid, as a yellow powder. Electrospray Mass Spec: 496.1 (M-H)- and 0.2g (11%) of the diacid, (3S,6S)-4-{[4-(2-

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butynyloxy)phenyl]sulfonyl}-6-(carboxymethyl)-2,2-dimethyl-3-thiomorpholine-carboxylic acid, as a yellow powder. Electrospray Mass Spec: 440 (M-H)-.

Step 4 According to the procedure of **Example 25**, 0.201g (0.404 mmol) of (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid furnished 0.074g (36%) of the hydroxamic acid, *tert*-butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl}acetate, as a white powder following chromatography on silica gel eluting with dichloromethane/methanol (10:1). Electrospray Mass Spec: 513.1 (M+H)+

Example 278

{(2S,5S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl}acetic acid

To a solution of 0.056g (0.1092 mmol) of *tert*-butyl{(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl}acetate (**Example 277**) in 2mL of dichloromethane was added 2mL of trifluoroacetic acid. After 2h the solution was concentrated in vacuo providing 0.052g (96%) of the carboxylic acid, {(2S,5S)-4-{[4-(2-butynyloxy)-phenyl]sulfonyl}-5-[(hydroxyamino)-carbonyl]-6,6-dimethylthiomorpholinyl}acetic acid, as a light powder. Electrospray Mass Spec: 457.1 (M+H)+

Example 279

(3S,6S)-4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-6-[2-(hydroxyamino)-2-oxoethyl]-2,2-dimethyl-3-thiomorpholinecarboxamide

According to the procedure of **Example 25**, 0.6967g (1.58 mmol) of the dicarboxylic acid from **Example 277**, (3S,6S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-6-(carboxymethyl)-2,2-dimethyl-3-thiomorpholinecarboxylic acid, furnished 0.093g (12%) of the dihydroxamic acid, (3S,6S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-6-[2-(hydroxyamino)-2-oxoethyl]-2,2-dimethyl-3-thiomorpholine-

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carboxamide, as a light powder following chromatography on silica gel eluting with dichloromethane/ methanol (10:1). Electrospray Mass Spec: 471.9 (M+H)+

Example 280

5 **(3S,6S)-6-(2-Amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide}**

Step 1 According to the procedure of Example 278, 2.33g (4.55 mmol) of methyl (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate (Step 2, Example 277) furnished 1.92g (93%)
10 of the carboxylic acid, [(2S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-(methoxycarbonyl)-6,6-dimethylthiomorpholinyl]acetic acid, as a white solid. Electrospray Mass Spec: 454.1 (M-H)-

Step 2 To a solution of 1.21g (2.66 mmol) of [(2S,5S)-4-{{[4-(2-butynyloxy)-
15 phenyl]sulfonyl}-5-(methoxycarbonyl)-6,6-dimethylthiomorpholinyl]acetic acid dissolved in 15 mL of DMF was added 0.884g (6.64 mmol) of 1-hydroxybenzotriazole hydrate (HOBT) followed by 1.53g (7.98 mmol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC). The resulting mixture was stirred at room temperature for 1h and then 3 mL of a 28% ammonium
20 hydroxide solution was added. The reaction was stirred overnight and then diluted with ethyl acetate. The organics were washed with 5% HCl solution, water and saturated sodium bicarbonate solution and then dried over sodium sulfate, filtered and concentrated in vacuo to provide 0.83g (69%) of the amide, methyl(3S,6S)-6-(2-amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)-phenyl]sulfonyl}-2,2-dimethyl-3-
25 thiomorpholinecarboxylate, as a yellow oil. Electrospray Mass Spec 455.1 (M+H)+

Step 3 Lithium iodide mediated ester cleavage, according to the procedure of Step 4 of Example 273, of 0.825g (1.82 mmol) of methyl(3S,6S)-6-(2-amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate
30 furnished 0.65g (81%) of the carboxylic acid, (3S,6S)-6-(2-amino-2-oxoethyl)-4-{{[4-

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(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid, as a viscous oil. Electrospray Mass Spec 441.1: (M+H)+

Step 4 According to the procedure of Example 25 0.077g (0.175 mmol) of (3S,6S)-6-(2-amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid furnished 0.043g (54%) of the hydroxamic acid, 3S,6S)-6-(2-amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide, as a light powder following chromatography on silica gel eluting with dichloromethane/ methanol (10:1). Electrospray Mass Spec: 455.1 (M+H)+

Example 281

(3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-[2-(dimethylamino)-2-oxoethyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide

Step 1 To a solution of 1.535g (3.09 mmol) of (3S,6S)-6-[2-(*tert*-butoxy)-2-oxoethyl]-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylic acid (Example 277) in 15mL of dichloromethane was added sequentially 0.43mL (3.09 mmol) of triethylamine, 0.905g (3.55 mmol) of bis(2-oxo-3-oxazolidinyl)phosphinic chloride, 0.493g (3.09 mmol) of O-benzyl hydroxylamine and an additional 1.29 mL (9.27 mmol) of triethylamine. After stirring overnight the mixture was concentrated in vacuo and partitioned between ethyl acetate and saturated aqueous sodium bicarbonate. The organic layer was washed consecutively with water and brine. Sodium sulfate was added to dry the organic layer which was subsequently filtered, concentrated in vacuo and chromatographed on silica gel eluting with hexanes/ethyl acetate (4:1) to furnish 1.5g (81%) of *tert*-butyl((2S,5S)-5-[[[(benzyloxy)amino]carbonyl]-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-6,6-dimethylthiomorpholinyl)acetate as a white solid. Electrospray Mass Spec: 603.1 (M+H)+

Step 2 According to the procedure of Example 278 0.3237g (0.538 mmol) of *tert*-butyl((2S,5S)-5-[[[(benzyloxy)amino]carbonyl]-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-6,6-dimethylthiomorpholinyl)acetate furnished 0.294g

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(100%) of the carboxylic acid, ((2S,5S)-5-(((benzyloxy)amino)carbonyl)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-6,6-dimethylthiomorpholinyl)acetic acid, as a white solid. Electrospray Mass Spec: 547.0 (M+H)+

- 5 **Step 3** To a solution of 0.283g (0.518 mmol) of ((2S,5S)-5-(((benzyloxy)-amino)carbonyl)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-6,6-dimethylthiomorpholinyl)-acetic acid dissolved in 15 mL of DMF was added 0.083g (0.662 mmol) of 1-hydroxy-benzotriazole hydrate (HOBt) followed by 0.132g (0.689 mmol) of 1-(3-dimethyl-aminopropyl)-3-ethylcarbodiimide hydrochloride (EDC). The resulting mixture was
- 10 stirred at room temperature for 1h and then 3 mL of a 3M solution of dimethylamine in THF was added. The reaction was then stirred overnight and then diluted with ethyl acetate. The organics were washed with 5% HCl solution, water and saturated sodium bicarbonate solution and then dried over sodium sulfate, filtered and concentrated in vacuo to provide 0.14g (47%) of the amide, (3S,6S)-N-(benzyloxy)-4-([4-(2-
- 15 butynyloxy)phenyl]sulfonyl)-6-[2-(dimethylamino)-2-oxoethyl]-2,2-dimethyl-3-thiomorpholinecarboxamide, as a clear oil. Electrospray Mass Spec 574.1 (M+H)+

- Step 4** To a solution of 0.064g (0.1116 mmol) of (3S,6S)-N-(benzyloxy)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-6-[2-(dimethylamino)-2-oxoethyl]-2,2-dimethyl-3-thio-
- 20 morpholinecarboxamide in 0.8 mL of trifluoroacetic acid cooled at 0° was added 0.335 mL (0.335 mmol) of a 1.0M solution of boron tris(trifluoroacetate). The resulting solution was stirred for 2h, concentrated in vacuo and purified by chromatography on silica gel eluting with dichloromethane/methanol (10:1) to provide 0.051g (94%) of the hydroxamic acid, (3S,6S)-4-([4-(2-
- 25 butynyloxy)phenyl]sulfonyl)-6-[2-(dimethylamino)-2-oxoethyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide, as a brown powder. Electrospray Mass Spec 484.1 (M+H)+

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Example 282

(3S,6S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide

Step 1 To a solution of 0.179g (0.327 mmol) of the product of Step 2 of **Example 281**, ((2S,5S)-5-{{(benzyloxy)amino}carbonyl}-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-6,6-dimethylthiomorpholinyl)acetic acid, dissolved in 5 mL of DMF was added 0.096 mL (0.69 mmol) of triethylamine, 50 mg of DMAP, 0.031 mL (0.36 mmol) of morpholine and 0.078 mL (0.36 mmol) of diphenylphosphoryl azide. After stirring for 12h the solution was partitioned between ethyl acetate and water. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by chromatography on silica gel eluting with hexanes/ethyl acetate (1:1) to furnish 0.1586g (79%) of (3S,6S)-N-(benzyloxy)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide as a light solid. Electrospray Mass Spec 616.4 (M+H)+

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Step 2 According to the procedure of Step 4 of **Example 281** 0.1431g (0.233 mmol) of (3S,6S)-N-(benzyloxy)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide furnished 0.1014g (83%) of the hydroxamic acid, (3S,6S)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide, as a brown solid. Electrospray Mass Spec 523.8 (M-H)-

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Example 283

(3S,6S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-methyl-1-piperazinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide hydrochloride

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Step 1 According to the procedure of Step 1 of **Example 282**, 0.234g (0.428 mmol) of the product of Step 2 of **Example 281**, ((2S,5S)-5-{{(benzyloxy)amino}carbonyl}-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-6,6-dimethylthiomorpholinyl)acetic acid and 0.052mL (0.47 mmol) of 1-methylpiperazine furnished 0.23g (86.1%) of (3S,6S)-N-(benzyloxy)-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-2,2-dimethyl-6-[2-(4-methyl-

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1-piperazinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide as a white solid after chromatography on silica gel eluting with dichloromethane/methanol (20:1). Electrospray Mass Spec 629.1 (M+H)+

- 5 **Step 2** To a solution of 0.2g (0.3185 mmol) of (3S,6S)-N-(benzyloxy)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-6-[2-(4-methyl-1-piperazinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide in 3 mL of trifluoroacetic acid cooled at 0° was added 0.96 mL (0.96 mmol) of a 1.0M solution of boron tris(trifluoroacetate). The resulting solution was stirred for 2h, concentrated in vacuo and then purified by
- 10 chromatography on silica gel eluting with dichloromethane/ methanol (10:1) to provide the free base which was then dissolved in 3 mL of methanol. Through this solution cooled to 0° was bubbled HCl gas for 2 minutes. The solution was concentrated in vacuo yielding 0.12g (66%) of (3S,6S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-methyl-1-piperazinyl)-2-oxoethyl]-3-thio-
- 15 morpholinecarboxamide hydrochloride as a brown powder. Electrospray Mass Spec 539.0 (M+H)+

Example 284

- (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-(2-{{[2-
- 20 (dimethylamino)ethyl]amino}-2-oxoethyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide

- Step 1** According to the procedure of Step 1 of **Example 282**, 0.234g (0.428 mmol) of ((2S,5S)-5-{{[(benzyloxy)amino]carbonyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-6,6-dimethylthiomorpholinyl}acetic acid and 0.052mL (0.47 mmol) of N,N-dimethyl-
- 25 ethylenediamine furnished 0.129g (49%) of (3S,6S)-N-(benzyloxy)-4-{{[4-(2-butynyl-oxo)phenyl]sulfonyl}-6-(2-{{[2-(dimethylamino)ethyl]amino}-2-oxoethyl)-2,2-dimethyl-3-thiomorpholinecarboxamide after chromatography on silica gel eluting with dichloromethane/methanol (20:1) as a white solid. Electrospray Mass Spec 617.0 (M+H)+

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Step 2 According to the procedure of Step 2 of **Example 283** 0.111g (0.18 mmol) of (3S,6S)-N-(benzyloxy)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-6-(2-{[2-(dimethylamino)ethyl]amino}-2-oxoethyl)-2,2-dimethyl-3-thiomorpholinecarboxamide and furnished 0.051g (50%) of desired hydrochloride salt, (3S,6S)-4-{[4-(2-butynyloxy)-
5 phenyl]sulfonyl}-6-(2-{[2-(dimethylamino)ethyl]amino}-2-oxoethyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride, as a brown powder.
Electrospray Mass Spec 527.0 (M+H)+

Example 285

10 **Methyl (3S,6S)-6-{{{tert-butoxycarbonyl}amino}methyl}-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate**

To a solution of 0.6138g (1.35 mmol) of the product of Step 1 of **Example 280**, [(2S,5S)-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-(methoxycarbonyl)-6,6-dimethylthiomorpholinyl]acetic acid, in 10 mL of t-butanol was added 0.188mL
15 (1.35 mmol) of triethylamine and 0.291 mL (1.35 mmol) of diphenylphosphoryl azide. The solution was heated at reflux for 12h, cooled to room temperature, concentrated in vacuo and chromatographed on silica gel eluting with hexanes/ethyl acetate (4:1) to provide 0.414 g (58%) of the carbamate, methyl (3S,6S)-6-{{{tert-butoxycarbonyl}-
amino}methyl}-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholine-
20 carboxylate. Electrospray Mass Spec: 527.1 (M+H)+.

Example 286

(4S)-3-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-5,5-dimethyl-1,3-thiazolidine-4-carboxamide

25 **Step 1** To a room temperature solution of 4.3 g (32.3 mmol) of 5,5-dimethyl-1,3-thiazolidine-4-carboxylic acid (*J. Med. Chem.* 1989, 32(2), 466 - 472.) in 30 ml of dioxane:water (2:1) containing 4.9 mL (35.5 mmol) of triethylamine was added 7.9 g (32.3 mmol) of 4-butynyloxybenzenesulfonyl chloride. The mixture was stirred at 25°C for 18 h. The resulting mixture was diluted with ethyl acetate and washed with 1N
30 aqueous hydrochloric acid (3X). The organic phase was dried over anhydrous magnesium sulfate and concentrated in vacuo to afford a foam which was

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chromatographed on silica gel eluting with methanol/dichloromethane to give (4S)-3-
 {[4-(2- butynyloxy)phenyl]sulfonyl}-5,5-dimethyl-1,3-thiazolidine-4-carboxylic acid as
 a white solid. Electrospray Mass Spec 368.1 (M-H)-

5 Step 2 To oxalyl chloride (4.5 mL of a 2 M solution in dichloromethane) in dichloromethane at 0°C was added DMF (0.69 mL). After 15 min a solution of (4S)-3-{[4-(2-butynyloxy)phenyl]sulfonyl}-5,5-dimethyl-1,3-thiazolidine-4-carboxylic acid (1.58 g, 4.5 mmol) in DMF was added and the resulting reaction mixture was stirred at room temperature for 1h.

10 In a separate flask, 9.4 mL of triethylamine was added to a 0°C mixture of 3.13 g of hydroxylamine hydrochloride in 97 mL of tetrahydrofuran and 24 mL of water. After this mixture had been stirred for 15 min at 0°C, the acid chloride solution was added to it in one portion and the resulting solution was allowed to warm to room temperature and stirred for another 18h. Ethyl acetate and aqueous sodium bicarbonate were then added to the reaction flask. The organic phase was washed with aqueous sodium bicarbonate and dried over anhydrous potassium carbonate. Concentration in vacuo and trituration with ether/dichloromethane gave (4S)-3-[[4-(2-butynyloxy)phenyl]sulfonyl]-N-hydroxy-5,5-dimethyl-1,3-thiazolidine-4-carboxamide as a white powder (1.2 g). Electrospray Mass Spec 385.3 (M+H)+

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Example 287

***tert*-Butyl 4-([4-(2-butynyloxy)phenyl]sulfonyl; amino)-4-
[(hydroxyamino)carbonyl]-1-piperidinecarboxylate**

Step 1 4-Amino-1-(*tert*-butoxycarbonyl)-4-piperidinecarboxylic acid (1.0 g, 4.09 mmol) in dioxane (5 mL) and water (2.5 mL) was treated with triethylamine (0.63 mL, 4.5 mmol) and 0.8 mL of 5N aqueous sodium hydroxide and 4-(2-butyloxy)phenyl sulfonyl chloride (1.0 g, 4.09 mmol) was then added. After 40h, ethyl acetate and 1N aqueous hydrochloric acid was added. The organic phase was washed an additional 2X with 1N aqueous hydrochloric acid and once with brine, then dried over anhydrous magnesium sulfate to give an oil (0.98 g) which was chromatographed on silica gel eluting with dichloromethane/methanol to give 1-(*tert*-butoxycarbonyl)-4-((4-(2-

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butynyloxy)phenyl]sulfonyl} amino)-4-piperidinecarboxylic acid as a white powder (0.36 g). Electrospray Mass Spec 453.1 (M+H)+.

Step 2 To oxalyl chloride (0.70 mL of a 2 M solution in dichloromethane) in dichloromethane (1 mL) at 0°C was added dimethylformamide (0.11 mL). After 15 min a solution of 1-(*tert*-butoxycarbonyl)-4-([4-(2-butynyloxy)phenyl]sulfonyl)-amino)-4-piperidinecarboxylic acid (0.315 g, 0.70 mmol) in dimethylformamide was added and the resulting reaction mixture was stirred at room temperature for 1 h.

In a separate flask, 1.46 mL of triethylamine was added to a 0°C mixture of 0.486 g of hydroxylamine hydrochloride in 15 mL of tetrahydrofuran and 3.7 mL of water. After this mixture stirred for 15 min at 0°C, the acid chloride solution was added to it in one portion and the resulting solution was allowed to warm to room temperature and stirred for another 18 h. Ethyl acetate and aqueous sodium bicarbonate were then added to the reaction flask. The organic phase was washed with aqueous sodium bicarbonate (3X) and dried over anhydrous potassium carbonate. Concentration in vacuo gave *tert*-butyl 4-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-4-[(hydroxyamino)carbonyl]-1-piperidinecarboxylate as a hard foam (0.142 g). Electrospray mass spec 468.2 (M+H)+.

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Example 288

4-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-4-piperidinecarboxamide

To a solution of *tert*-butyl 4-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-4-[(hydroxyamino)carbonyl]-1-piperidinecarboxylate (0.114 g) from **Example 287**, in dioxane (1 mL) was added 4N hydrochloric acid in dioxane (2 mL). After 4 hours the reaction mixture was concentrated in vacuo. Trituration with dichloromethane and diethyl ether gave 4-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-4-piperidinecarboxamide as an off-white powder. Electrospray Mass Spec 368.2 (M+H)+.

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Example 289**1-Benzoyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide**

Step 1 To a solution of tert-butyl 1,4-diazepane-5-carboxylate (WO 98/08823)(4.5 g, 22.5 mmol) in dioxane (225 mL) was added water (200 mL) and 1N aqueous sodium hydroxide (22.5 mL). Di-tert-butyl dicarbonate (4.91 g, 22.5 mmol) was then added. After 18 hours triethylamine (9.4 mL, 67 mmol), 4-dimethylaminopyridine (0.274 g, 2.25 mmol) and 4-(2-butynyloxy)phenyl]sulfonyl chloride (6.61 g, 27 mmol) were added. After stirring overnight 1 N aqueous hydrochloric acid (100 mL) was added and the mixture was extracted with dichloromethane. The combined organic extracts were dried over anhydrous potassium carbonate and concentrated in vacuo. Chromatography on silica gel eluting with dichloromethane/methanol gave a yellow glass (4.52 g). Chromatography of this material on silica gel with hexane/ethyl acetate gave di(tert-butyl) 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-1,5-dicarboxylate as a glass (0.83 g). Electrospray Mass Spec 509.3 (M+H)+

Step 2 Treatment of di(tert-butyl) 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-1,5-dicarboxylate (0.83 g, 1.63 mmol) with 2N hydrochloric acid in dioxane (30 mL) at 25°C for 2 hours gave, after concentration in vacuo, a quantitative yield of tert-butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate. Electrospray Mass Spec 409.3 (M+H)

Step 3 tert-Butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate (0.425 g, 0.96 mmol) in dichloromethane at 25°C (10 mL) was treated with triethylamine (0.28 mL, 2.02 mmol) followed by benzoyl chloride (0.12 mL, 1.06 mmol) and dimethylaminopyridine (10 mg). After 18 hours aqueous workup gave tert-butyl 1-benzoyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate. ¹H NMR (dmso-d₆, 300 MHz): 1.24 (s, 9H, t-bu), 1.82 (s, 3H, CH₃), 2.0-4.0 (m, 8H, CH₂), 4.65 (s, 1H, CH), 4.85 (s, 2H, CH₂), 7.0 – 7.9 (m, 9H, ArH). Treatment with trifluoroacetic acid (4 mL) in dichloromethane (10 mL) for 6 hours gave, after concentration in vacuo followed by chromatography on silica gel eluting

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with dichloromethane/methanol, 1-benzoyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid as a foam (0.328 g).

Step 4 To oxalyl chloride (0.72 mL of a 2 M solution in dichloromethane) in dichloromethane (1 mL) at 0°C was added dimethylformamide (0.11 mL). After 15 min a solution of 1-benzoyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid (0.328 g, 0.718 mmol) in dimethylformamide was added and the resulting reaction mixture was stirred at room temperature for 1h.

In a separate flask, 1.5 mL of triethylamine was added to a 0°C mixture of 0.50 g of hydroxylamine hydrochloride in 15.4 mL of tetrahydrofuran and 3.8 mL of water. After this mixture stirred for 15 min at 0°C, the acid chloride solution was added to it in one portion and the resulting solution was allowed to warm to room temperature and stirred for another 18 h. Ethyl acetate and aqueous sodium bicarbonate were then added to the reaction flask. The organic phase was washed with aqueous sodium bicarbonate (3X) and dried over anhydrous potassium carbonate. Concentration in vacuo gave a thick gum (0.35 g) which was chromatographed on silica gel eluting with dichloromethane/methanol to give an off-white foam (0.22 g) which was triturated with diethyl ether to give 1-benzoyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide as an off white powder (0.173 g). Electrospray Mass Spec 472.3 (M+H)+.

Example 290

1-Benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide

Step 1 To 10 mL of a methanolic solution of the product of Step 2 of Example 289, tert-butyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate, (0.37 g, 0.84 mmol) was added triethylamine (0.25 mL, 1.8 mmol), benzyl bromide (0.11 mL, 0.92 mmol) and a catalytic amount of tetrabutylammonium iodide. After 18 hours 5% aqueous sodium bicarbonate was added and the mixture extracted with dichloromethane (4X). The combined organic extracts were dried over anhydrous magnesium sulfate and concentrated in vacuo to give an oil (0.51 g). Chromatography on silica gel gave

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tert-butyl 1-benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate as a clear colorless oil (0.34 g).

Step 2 To a solution of *tert*-butyl 1-benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylate (0.34 g, 0.68 mmol) in dichloromethane (2 mL) at 0°C was added trifluoroacetic acid (1.23 mL). After 2.5h the reaction mixture was allowed to warm to 25°C whereupon an additional 1 mL of trifluoroacetic acid was added. After 18h the reaction mixture was concentrated in vacuo to provide 1-benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid as a white powder.

Electrospray Mass Spec 443.4 (M+H)+

Step 3 In a manner analogous to that described in Step 4 of Example 289, 1-benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid (0.68 mmol) was converted into 1-benzyl-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide (0.169 g), obtained as a white solid. Electrospray Mass Spec 458.2 (M+H)+

Example 291

***tert*-Butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-1,4-diazepane-1-carboxylate**

Step 1 In a manner analogous to that described in Step 2 of Example 290, 2.86 g (5.78 mmol) of di(*tert*-butyl) 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-1,5-dicarboxylate (from Step 1 of Example 289) was converted into 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid which was purified by chromatography on silica gel to give a yellow solid. Electrospray Mass Spec 353.1 (M+H)+

Step 2 To a solution of 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid (2.9 mmol) in dioxane (30 mL) and water (30 mL) was added 1N aqueous sodium hydroxide (9 mL). Di-*tert*-butyl dicarbonate (0.63 g, 2.9 mmol) was then added. After 18h 1 N aqueous hydrochloric acid (15 mL) was added and the mixture was extracted with dichloromethane (3X). The combined organic extracts were dried over anhydrous sodium sulfate and concentrated in vacuo to give *tert*-

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butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid -1-carboxylate as a brown foam (1.24 g).

Step 3 To a solution of tert-butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-diazepane-5-carboxylic acid-1-carboxylate (0.74 g, 1.6 mmol) in dimethylformamide (8 mL) at 0°C was added 1-hydroxybenzotriazole (0.39 g, 2.9 mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide (0.56 g, 2.9 mmol). After 45 min 50% aqueous hydroxyl amine (0.26 mL) was added. After 2 hours the reaction mixture was diluted with ethyl acetate and water. The aqueous phase was extracted with ethyl acetate 3X. The combined organic phases were washed with aqueous sodium bicarbonate 3X and with water 4X. The organic phase was dried over anhydrous sodium sulfate and concentrated in vacuo to give tert-butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-1,4-diazepane-1-carboxylate (0.62 g). Electrospray Mass Spec 468.1 (M+H)+

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Example 292

4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide

To the product of **Example 291**, tert-butyl 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-1,4-diazepane-1-carboxylate (0.32 g, 0.68 mmol), was added 4N hydrochloric acid in dioxane (9 mL). After 10 min the reaction mixture was concentrated in vacuo. Trituration of the residue with diethyl ether gave 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide as an off-white powder (0.27 g). Electrospray Mass Spec 368.2 (M+H)+

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Example 293

4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-methyl-1,4-diazepane-5-carboxamide

Triethylamine (0.08 mL) was added to a suspension of the product of **Example 292**, 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide (0.10 g), in methanol (6 mL) to give a solution which was cooled to 0°C. Iodomethane (0.025 mL) was then added. After 30 min the reaction mixture was

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allowed to warm to 25°C. After 20 min additional iodomethane (0.02 mL) was added followed by additional triethylamine (0.015 mL). After 18 hours the reaction mixture was diluted with dichloromethane and water. The aqueous phase was washed with dichloromethane (3X). The combined organic extracts were dried over anhydrous sodium sulfate and concentrated in vacuo. The material obtained was combined with material from a previous reaction run on the same scale and chromatographed on silica gel to give 4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-methyl-1,4-diazepane-5-carboxamide (0.067 g). Electrospray Mass Spec 382.2 (M+H)+

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Example 294

4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-thiazepine-5-carboxamide

Step 1 To D,L-homocysteine (6.69 g, 49.4 mmol) was added 2N aqueous potassium hydroxide (32 mL) and the resulting solution was cooled to 0°C. 2-Bromoethanol (4.2 mL, 59.3 mmol) in ethanol (56 mL) was then added dropwise and the reaction mixture was allowed to warm to 25°C. After 18 h the reaction mixture was acidified to pH 5 and concentrated to give 2-(amino)-4-[(2-hydroxyethyl)sulfanyl]butanoic acid (WO 9808823) as a white paste. To this material was added water (110 mL) and dioxane (110 mL) and triethylamine (20.7 mL, 148 mmol) and to the resulting solution was added 4-(2-butynyloxy)phenylsulfonyl chloride (14.2 g, 54.3 mmol). After 20h the reaction mixture was acidified to pH 1 with 1N aqueous hydrochloric acid and extracted with dichloromethane (3X). The combined organic extracts were dried over anhydrous sodium sulfate and concentrated in vacuo to give 2-({[4-(2-butynyloxy)-phenyl]sulfonyl}amino)-4-[(2-hydroxyethyl)sulfanyl]butanoic acid as an oil (20.8 g). Electrospray Mass Spec 385.8 (M-H)-.

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Step 2 To a solution of 2-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-4-[(2-hydroxyethyl)sulfanyl]butanoic acid (20.8 g) in ether and methanol was dropwise added trimethylsilyldiazomethane (25 mL, 2.0 M in hexanes). The reaction mixture was concentrated in vacuo and the resulting oil was chromatographed on silica gel eluting with hexane/ethyl acetate to give methyl 2-({[4-(2-butynyloxy)phenyl]-sulfonyl}-

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amino)-4-[(2-hydroxyethyl)sulfanyl] butanoate as a light yellow oil (6.68 g).
Electrospray Mass Spec 401.9 (M+H)+.

Step 3 To methyl 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino)-4-[(2-hydroxy-
5 ethyl)-sulfanyl] butanoate (5.5 g, 13.7 mmol) in tetrahydrofuran (100 mL) was added
triphenylphosphine (4.3 g, 16.4 mmol). Diethyl azodicarboxylate (2.4 mL, 15.1
mmol) was then added dropwise. After 2 h the reaction mixture was concentrated in
vacuo to give an oil which was chromatographed on silica gel eluting with
hexane/ethyl acetate to give methyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-
10 thiazepine-5-carboxylate as a white solid (4.04 g). mp 95 – 98°C. Electrospray Mass
Spec 384.0 (M+H)+.

Step 4 To methyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-thiazepine-5-
carboxylate (0.27 g, 0.7 mmol) was added 5 N aqueous sodium hydroxide (7 mL) and
15 methanol (7 mL). The reaction mixture was heated at reflux for 5 minutes. Upon
cooling to 25°C the reaction mixture was acidified to pH 1 with 1N aqueous
hydrochloric acid. The mixture was extracted with dichloromethane (3X) and the
combined organic extracts were dried over anhydrous sodium sulfate. Concentration
in vacuo gave 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-thiazepine-5-carboxylic acid
20 as a white powder (0.26 g). Electrospray Mass Spec 370.0 (M+H)+.

Step 5 A solution of 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-1,4-thiazepine-5-
carboxylic acid (0.23 g, 0.62 mL) in dimethylformamide (3.5 mL) at 0°C was treated
with 1-hydroxybenzotriazole (0.15 g, 1.1 mmol) and 1-(3-dimethylaminopropyl)-3-
25 ethylcarbodiimide (0.21 g, 1.1 mmol). After 45 min 50% aqueous hydroxylamine
(0.2 mL) was added dropwise and the reaction mixture was allowed to warm to 25°C.
After 72 h ethyl acetate and water were added and the organic phase washed with
ethyl acetate (3X). The combined organic extracts were dried over anhydrous sodium
sulfate and concentrated in vacuo to give 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-
30 hydroxy-1,4-thiazepine-5-carboxamide as a hard white foam (0.20 g). Electrospray
Mass Spec 385 (M+H)+.

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Example 328**(2R)-5-(acetylamino)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide**

- 5 Step A. (2R)-5-(*tert*-butyloxycarbonylamino)-2-([4-(but-2-ynyloxy)phenyl]-sulfonyl)amino)-N-hydroxypentanoic acid

D-Orn(Boc) (4.0 g, 17.2 mmol) was dissolved in dioxane (20 mL) and water (20 mL) and 4-but-2-ynyloxy-benzenesulfonyl chloride (4.0 g, 16.4 mmol) and triethylamine (4.4 mL, 31.6 mmol) were added. The mixture was stirred at room temperature
10 for 18 hours. The solvent was evaporated and the residue dissolved in ethyl acetate and washed with brine and dried over MgSO₄ and concentrated. The crude product was used directly in Step B.

Step B. Coupling of sulfonylated amino acid to hydroxylamine resin.

- 15 4-*O*-Methylhydroxylamine-phenoxyethyl-copoly(styrene-1%-divinylbenzene)-resin¹ (20.0 g, 1.1 meq/g) was placed in a 250 mL solid phase synthesis vessel (Chem Glass) and suspended in DMF (100 mL). D-2-(4-but-2-ynyloxy-benzenesulfonylamino)-5-*tert*-butoxycarbonylaminopentanoic acid (9 g, 1.0 eq.) HOBt (16.2 g, 6.0 eq.) and DIC (12.5 mL, 4.0 eq.) were added. The reaction was shaken on
20 an orbital shaker at room temperature for 16 hours. The reaction was filtered and washed with DMF (3 x 50 mL), DCM (3 x 50 mL), MeOH (2 x 50 mL), and DCM (2 x 50 mL). The resin was dried *in vacuo* at room temperature.

Step C. Removal of the Boc group

- 25 The dried resin from Step B was placed in a 250 mL solid phase synthesis vessel and 2,6-lutidine (1.5 M solution in DCM, 50 mL) followed by trimethylsilyltriflate (1.0 M solution in DCM, 50 mL) were added. The reaction was shaken for 30 minutes, then filtered and the resin washed with DCM (2 x 50 mL). 2,6-Lutidine (1.5 M solution in DCM, 50 mL) followed by trimethylsilyltriflate (1.0 M solution in DCM,
30 50 mL) were again added and the reaction was shaken for a further 30 minutes, then filtered and the resin washed with DCM (2 x 50 mL), DMF (3 x 50 mL), DCM (3 x 50

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mL), MeOH (2 x 50 mL), and DCM (2 x 50 mL) The resin was dried *in vacuo* at room temperature.

Step D: Acylation of ornitine side chain.

5 The resin from Step C was split into 24 empty 25 mL SPE column (Jones Chromatography USA, Inc. Part # 120-1024-H) and suspended in DMF (4 mL). To the first tube was added acetic acid (76 uL, 2.0 eq.) HOBt (541 mg, 6.0 eq.) and DIC (417 uL, 4.0 eq.) were added. The reaction was shaken on an orbital shaker at room temperature for 16 hours. The reaction was filtered and washed with DMF (3 x 20
10 mL), DCM (3 x 20 mL), MeOH (2 x 20 mL), and DCM (2 x 20 mL).

Step E: Cleavage of the product from resin.

The resin prepared in Step D was suspended in DCM (1.0 mL) and TFA (1.0 mL) was added. The reaction was shaken for 1 hour at room temperature. The
15 reaction was filtered and the resin washed with DCM (2 x 1 mL). The filtrate and the washing were combined and concentrated to dryness on a Savant SpeedVac. MeOH (1 mL) was added and the mixture concentrated.

The crude product was purified by reverse phase HPLC under the under the conditions described for **Example 62B**.

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The hydroxamic acid compounds described in Table 2 below are synthesized according to the procedures of **Example 328** using either D-Orn(Boc) or D-Lys(Boc) and the following acids in Step D: acetic acid, 5-benzimidazole carboxylic acid, benzoic acid, 4-bromobenzoic acid, butyric acid, 3-chlorothiophene-2-carboxylic acid, 4-
25 chlorobenzoic acid, cyclohexane carboxylic acid, 3,4-dichlorophenyl acetic acid, 2,5-dimethyl-3-furoic acid, 3,5-dimethylisoxazole-4-carboxylic acid, hydrocinnamic acid, isonicotinic acid, nicotinic acid, *o*-anisic acid, *p*-anisic acid, *p*-nitrophenyl acetic acid, phenylacetic acid, 3-quinoline carboxylic acid, 3-thiophenecarboxylic acid, trans-cinnamic acid, and oleic acid.

30

Table 2

Example	R	HPLC retention time ⁵ (min.)	MS ³ (M+H)
328	D-Orn(Ac)	1.91	398
329	D-Orn(5-benzimidazolyl)	1.98	500
330	D-Orn(benzoyl)	2.33	460
331	D-Orn(4-bromobenzoyl)	2.59	539
332	D-Orn(butyryl)	2.12	426
333	D-Orn(3-chlorothiophene-2-carbonyl)	2.43	501
334	D-Orn(4-chlorobenzoyl)	2.55	494
335	D-Orn(cyclohexylcarbonyl)	2.44	466
336	D-Orn(2,5-dimethyl-3-furoyl)	2.74	543
337	D-Orn(3,4-dichlorophenyl acetyl)	2.45	478
338	D-Orn(3,5-dimethylisoxazole-4-carbonyl)	2.18	479
339	D-Orn(hydrocinnamoyl)	2.48	488
340	D-Orn(isonicotinyl)	1.78	461
341	D-Orn(nicotinyl)	1.81	461
342	D-Orn(o-methoxybenzoyl)	2.41	490
343	D-Orn(p-methoxybenzoyl)	2.36	490
344	D-Orn(p-nitrobenzoyl)	2.45	519
345	D-Orn(phenylacetyl)	2.38	474
346	D-Orn(3-quinoline carbonyl)	2.06	511
347	D-Orn(3-thiophene carbonyl)	2.28	466
348	D-Orn(cinnamoyl)	2.52	486
349	D-Lys(5-benzimidazolyl)	2.01	514
350	D-Lys(benzoyl)	2.39	474
351	D-Lys(4-bromobenzoyl)	2.65	553
352	D-Lys(3-chlorothiophene-2-carbonyl)	2.5	515
353	D-Lys(4-chlorobenzoyl)	2.61	509

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Example	R	HPLC retention time ⁵ (min.)	MS ³ (M+H)
354	D-Lys(cyclohexylcarbonyl)	2.49	480
355	D-Lys(3,4-dichlorophenyl acetyl)	2.63	557
356	D-Lys(2,5-dimethyl-3-furoyl)	2.51	492
357	D-Lys(3,5-dimethylisoxazole-4-carbonyl)	2.22	493
358	D-Lys(hydrocinnamoyl)	2.51	502
359	D-Lys(isonicotinyl)	2.01	475
360	D-Lys(o-methoxybenzoyl)	2.47	504
361	D-Lys(p-methoxybenzoyl)	2.41	504
362	D-Lys(p-nitrobenzoyl)	2.5	533
363	D-Lys(phenylacetyl)	2.42	488
364	D-Lys(3-quinoline carbonyl)	2.1	525
365	D-Lys(3-thiophene carbonyl)	2.33	480
366	D-Lys(cinnamoyl)	2.57	500
367	D-Orn(Z-octadec-9-enoyl)	4.35	620

⁵LC conditions: Hewlett Packard 1100; YMC ODS-A 4.6 mm x 50 mm 5 u column at 23°C; 10uL injection; Solvent A: 0.05% TFA/water; Solvent B:0.05% TFA/acetonitrile; Gradient: Time 0: 98% A; 0.5 min: 98% A; 4.5 min: 5% A, 5.0 min: 5% A. Flow rate 2.5 mL/min; Detection: 220 and 254 nm DAD.

Example 368

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]thiophene-2-carboxamide

- 10 Step A: (2R)-2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-*tert*-butoxycarbonyl-aminopentanoic acid *O-tert*-butylhydroxyamide (2R)-2-(4-but-2-ynyloxy-benzene-sulfonylamino)-5-*tert*-butoxycarbonylaminopentanoic acid (10 g, 22.7 mmol) prepared as described in **Example 328** Step A was dissolved in DCM (100 mL) and HOBt (3.7 g, 27.4 mmol), *O-tert*-Butyl hydroxylamine hydrochloride (4.2 g, 33.4 mmol)
- 15 triethylamine (9.4 mL, 67 mmol) and EDC (5 g, 32.2 mmol) were added in that order.

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The reaction was stirred at room temperature for 16 hours, then diluted with ethyl acetate and washed with water, dried over MgSO_4 and concentrated.

5 Step B: (2R)-2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-aminopentanoic acid *O*-*tert*-butylhydroxyamide

The residue from Step A was dissolved in 2,6-lutidine (1.5 M in DCM, 33 mL, 50 mmol) and trimethylsilyltriflate (1.0 M in DCM, 33 mL, 33 mmol) was added. The reaction was stirred for 2 hours then diluted with ethyl acetate and washed with water and saturated aqueous sodium bicarbonate. The organic phase was dried over MgSO_4 and concentrated.

Step C: N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(*O*-*tert*-butylhydroxyamino)-5-oxopentyl]thiophene-2-carboxamide

15 The residue from Step B (102 mg, 0.25 mmol) was dissolved in DCM (2 mL). Triethylamine (104 μL , 0.75 mmol), DMAP (0.3 mg, 0.025 mmol) and thiophene-2-carbonyl chloride (55 mg, 0.37 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

20 Step D: N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-thiophene-2-carboxamide

The residue from Step C was dissolved in DCM (1 mL) and TFA (1 mL) was added. The solution was shaken at 40°C for 5 hours, then concentrated. The residue was dissolved in MeOH and purified by reverse phase HPLC under the conditions described below to give **Example 368** (8.5 mg) Electrospray Mass Spec 466 (M+H)⁺;

25 HPLC retention time⁵ 3.06 minutes.

Flow Rate: 22.5 mL/minute.

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Example 369

**(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-
{[(ethylamino)carbonyl]amino}-N-hydroxypentanamide**

5 Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was dissolved in DCM (2 mL) and triethylamine (69 uL, 0.5 mmol) and ethyl isocyanate (22 uL, 0.27 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

10 Step B: The procedure used in **Example 368**, Step D was used to give **Example 369** (7.2 mg) Electrospray Mass Spec 427 (M+H)⁺; HPLC retention time⁵ 2.26 minutes.

Example 370

15 **(2R)-5-[(Anilinocarbonyl)amino]-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-
N-hydroxypentanamide**

20 Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was dissolved in DCM (2 mL) and triethylamine (69 uL, 0.5 mmol) and phenyl isocyanate (2230 uL, 0.27 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

Step B: The procedure used in **Example 368** Step D was used to give **Example 370** (21.3 mg) Electrospray Mass Spec 475 (M+H)⁺; HPLC retention time⁵ 2.7 minutes.

25 **Example 371**

**Octyl (4R)-4-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-
oxopentylcarbamate**

30 Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was dissolved in DCM (2 mL) and diisopropylethylamine (87 uL, 0.5 mmol) and octyl chloroformate (54 uL, 0.27 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

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Step B: The procedure used in **Example 368 Step D** was used to give **Example 371** (5.2 mg) Electrospray Mass Spec 512 (M+H)+; HPLC retention time⁵ 2.52 minutes.

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Example 372

4-Methoxyphenyl (4R)-4-({4-(but-2-ynyloxy)phenyl}sulfonyl)amino)-5-(hydroxyamino)-5-oxopentylcarbamate

Step A: The residue from **Example 368 Step B** (102 mg, 0.25 mmol) was dissolved in DCM (2 mL) and diisopropylethylamine (87 uL, 0.5 mmol) and 4-methoxyphenyl chloroformate (41 uL, 0.27 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

Step B: The procedure used in **Example 368 Step D** was used to give **Example 372** (14.7 mg) Electrospray Mass Spec 506 (M+H)+; HPLC retention time⁵ 2.82 minutes.

Example 373

(2R)-2-({4-(But-2-ynyloxy)phenyl}sulfonyl)amino)-5- {[(diethylamino)carbonyl]amino}-N-hydroxypentanamide

20

Step A: The residue from **Example 368 Step B** (102 mg, 0.25 mmol) was dissolved in DCM (2 mL) and triethylamine (69 uL, 0.5 mmol) and diethyl carbamoyl chloride (35 uL, 0.27 mmol) were added. The reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

25

Step B: The procedure used in **Example 368 Step D** was used to give **Example 373** (19.7 mg) Electrospray Mass Spec 455 (M+H)+; HPLC retention time⁵ 2.52 minutes.

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Example 374

**(2R)-2-([4-(But-2-ynoxy)phenyl]sulfonyl)amino)-N-hydroxy-5-
{[(methylanilino)carbonyl]amino}pentanamide**

Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was dissolved
5 in DCM (2 mL) and triethylamine (69 μ L, 0.5 mmol) and methylphenyl
carbamoyl chloride (46 mg, 0.27 mmol) were added. The reaction was shaken on an
orbital shaker for 16 hours then concentrated to dryness.

Step B: The procedure used in **Example 368** Step D was used to give **Example**
10 **374** (28 mg) Electrospray Mass Spec 489 (M+H)⁺; HPLC retention time⁵ 2.73
minutes.

Example 375

**(2R)-2-([4-(But-2-ynoxy)phenyl]sulfonyl)amino)-N-hydroxy-5-
15 {[(1-methyl-1H-imidazol-4-yl)sulfonyl]amino}pentanamide**

Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was dissolved
in DCM (2 mL) and diisopropylethylamine (87 μ L, 0.5 mmol) and 1-methylimidazole-
4-sulfonyl chloride (50 mg, 0.27 mmol) were added. The reaction was shaken on an
orbital shaker for 16 hours then concentrated to dryness.

20

Step B: The procedure used in **Example 368** Step D was used to give **Example**
375 (9.5 mg) Electrospray Mass Spec 500 (M+H)⁺; HPLC retention time⁵ 2.28
minutes.

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Example 376

**(2R)-2-([4-(But-2-ynoxy)phenyl]sulfonyl)amino)-N-hydroxy-5-[(2-morpholin-
4-ylacetyl)amino]pentanamide**

Step A: The residue from **Example 368** Step B (102 mg, 0.25 mmol) was
dissolved in DCM (2 mL) and triethylamine (87 μ L, 0.5 mmol), DMAP (0.3
30 mg, 0.025 mmol) and chloroacetyl chloride (30 μ L, 0.27 mmol) were added. The
reaction was shaken on an orbital shaker for 16 hours then concentrated to dryness.

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Step B: The residue from Step A was dissolved in DCM (2 mL) and morpholine (87 uL, 1.0 mmol) was added. The reaction was shaken at room temperature for 16 hours, then concentrated to dryness.

5

Step C: The procedure used in **Example 368** Step D was used to give **Example 376** (23.1 mg) Electrospray Mass Spec 483 (M+H)⁺; HPLC retention time^s 1.92 minutes.

10

Example 377

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-{[2-(4-methylpiperazin-1-yl)acetyl]amino}pentanamide

Step A: The residue from **Example 376** Step A was dissolved in DCM (2 mL) and N-methyl piperazine (110 uL, 1.0 mmol) was added. The reaction was shaken at room temperature for 16 hours, then concentrated to dryness.

15

Step B: The procedure used in **Example 368** Step D was used to give **Example 377** (16.8 mg) Electrospray Mass Spec 496 (M+H)⁺; HPLC retention time^s 1.89 minutes.

20

Example 378

(2R)-5-{[2-(Benzylamino)acetyl]amino}-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide

Step A: The residue from **Example 376** Step A was dissolved in DCM (2 mL) and benzylamine (110 uL, 1.0 mmol) was added. The reaction was shaken at room temperature for 16 hours, then concentrated to dryness.

25

Step B: The procedure used in **Example 368**, Step D was used to give **Example 378** (20.2 mg) Electrospray Mass Spec 503 (M+H)⁺; HPLC retention time^s 3.64 minutes.

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Example 379**(3S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxamide}**

Step 1 The product of Step 3 of **Example 243**, 4-(4-hydroxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid methyl ester (2.00g, 5.746 mmol), and 2-butyn-1-ol (0.52mL, 6.916 mmol) underwent Mitsunobu coupling according to the procedure of Step 4 of Example 243 to provide 1.68g of methyl (3S)-4-({[4-(2-butynyloxy)-phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate as a white solid.

10

Step 2 To a 0°C solution of 1.68g (4.23 mmol) of methyl (3S)-4-({[4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate in 100 mL of dichloromethane and 16 mL of methanol was added 0.730g of m-chloroperbenzoic acid in four equal portions, as a solid. Thirty minutes after all of the m-chloroperbenzoic acid had been added, the reaction was diluted with dichloromethane and washed with saturated sodium bicarbonate solution. The organics were dried over sodium sulfate, filtered and concentrated in vacuo. The residue was chromatographed on silica gel eluting with a gradient of ethyl acetate/hexanes (1:1) to ethyl acetate to provide 1.50g of a 3:1 mixture of sulfoxide diastereomers, methyl (3S)-4-({[4-(2-butynyloxy)phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate-1-oxide, which was used for the next step.

20

Step 3 A solution of 1.50g (3.632 mmol) of methyl (3S)-4-({[4-(2-butynyloxy)-phenyl]sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylate-1-oxide in 20 mL of acetic anhydride was heated to reflux for 4h and then concentrated in vacuo. The residue was chromatographed on silica gel eluting with ethyl acetate/hexanes (1:10) to provide 0.985g of methyl(3S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxylate as a colorless oil. Electrospray Mass Spec 396.1 (M+H)+.

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Step 4 Lithium iodide (0.770g, 5.75 mmol) mediated ester cleavage of 0.227g (0.575 mmol) of methyl(3S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxylate according to the procedure of **Example 250** provided 0.205g of (3S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxylic acid as a white solid. Electrospray Mass Spec 382.0 (M+H)+.

Step 5 According to the procedure of **Example 9**, 0.200g (0.525 mmol) of (3S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxylic acid was converted into 0.173g of the corresponding hydroxamic acid, (3S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3,4-dihydro-2H-1,4-thiazine-3-carboxamide, obtained as a white solid. Electrospray Mass Spec 396.9 (M+H)+.

15

Pharmacology

Representative compounds of this invention were evaluated as inhibitors of the enzymes MMP-1, MMP-9, MMP-13 and TNF- α converting enzyme (TACE). The standard pharmacological test procedures used, and results obtained which establish this biological profile are shown below.

20

Test Procedures for Measuring MMP-1, MMP-9, and MMP-13 Inhibition

These standard pharmacological test procedures are based on the cleavage of a thiopeptide substrates such as Ac-Pro-Leu-Gly(2-mercapto-4-methyl-pentanoyl)-Leu-Gly-OEt by the matrix metalloproteinases MMP-1, MMP-13 (collagenases) or MMP-9 (gelatinase), which results in the release of a substrate product that reacts colorimetrically with DTNB (5,5'-dithiobis(2-nitro-benzoic acid)). The enzyme activity is measured by the rate of the color increase. The thiopeptide substrate is made up fresh as a 20 mM stock in 100% DMSO and the DTNB is dissolved in 100% DMSO as a 100 mM stock and stored in the dark at room temperature. Both the substrate and DTNB are diluted together to 1 mM with substrate buffer (50 mM HEPES pH 7.5, 5 mM CaCl₂) before use. The stock of enzyme is diluted with

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buffer (50 mM HEPES, pH 7.5, 5 mM CaCl_2 , 0.02% Brij) to the desired final concentration. The buffer, enzyme, vehicle or inhibitor, and DTNB/substrate are added in this order to a 96 well plate (total reaction volume of 200 μL) and the increase in color is monitored spectrophotometrically for 5 minutes at 405 nm on a plate reader and the increase in color over time is plotted as a linear line.

Alternatively, a fluorescent peptide substrate is used. In this test procedure, the peptide substrate contains a fluorescent group and a quenching group. Upon cleavage of the substrate by an MMP, the fluorescence that is generated is quantitated on the fluorescence plate reader. The assay is run in HCBC assay buffer (50mM HEPES, pH 7.0, 5 mM Ca^{+2} , 0.02% Brij, 0.5% Cysteine), with human recombinant MMP-1, MMP-9, or MMP-13. The substrate is dissolved in methanol and stored frozen in 1 mM aliquots. For the assay, substrate and enzymes are diluted in HCBC buffer to the desired concentrations. Compounds are added to the 96 well plate containing enzyme and the reaction is started by the addition of substrate. The reaction is read (excitation 340 nm, emission 444 nm) for 10 min. and the increase in fluorescence over time is plotted as a linear line.

For either the thiopeptide or fluorescent peptide test procedures, the slope of the line is calculated and represents the reaction rate. The linearity of the reaction rate is confirmed ($r^2 > 0.85$). The mean ($\bar{x} \pm \text{sem}$) of the control rate is calculated and compared for statistical significance ($p < 0.05$) with drug-treated rates using Dunnett's multiple comparison test. Dose-response relationships can be generated using multiple doses of drug and IC_{50} values with 95% CI are estimated using linear regression.

25 Test Procedure for Measuring TACE Inhibition

Using 96-well black microtiter plates, each well receives a solution composed of 10 μL TACE (final concentration 1 $\mu\text{g/mL}$), 70 μL Tris buffer, pH 7.4 containing 10% glycerol (final concentration 10 mM), and 10 μL of test compound solution in DMSO (final concentration 1 μM , DMSO concentration $< 1\%$) and incubated for 10 minutes at room temperature. The reaction is initiated by addition of a fluorescent

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peptidyl substrate (final concentration 100 μ M) to each well and then shaking on a shaker for 5 sec.

The reaction is read (excitation 340 nm, emission 420 nm) for 10 min. and the increase in fluorescence over time is plotted as a linear line. The slope of the line is calculated and represents the reaction rate.

The linearity of the reaction rate is confirmed ($r^2 > 0.85$). The mean ($\bar{x} \pm \text{sem}$) of the control rate is calculated and compared for statistical significance ($p < 0.05$) with drug-treated rates using Dunnett's multiple comparison test. Dose-response relationships can be generated using multiple doses of drug and IC_{50} values with 95% CI are estimated using linear regression.

Human Monocytic THP-1 Cell Differentiation Assay For Soluble Proteins (THP-1 Soluble Protein Assay)

Mitogenic stimulation of THP-1 cells cause differentiation into macrophage like cells with concomitant secretion of tumor necrosis factor (TNF- α) and TNF receptor (TNF-R p75/80 and TNF-R p55/60) and Interleukin-8 (IL-8), among other proteins. In addition, non-stimulated THP-1 cells shed both the p75/80 and the p55/60 receptors over time. The release of membrane bound TNF- α and possibly TNF-R p75/80 and TNF-R p55/60, but not IL-8, is mediated by an enzyme called TNF- α converting enzyme or TACE. This assay can be used to demonstrate either an inhibitory or a stimulatory compound effect on this TACE enzyme and any cytotoxic consequence of such a compound.

THP-1 cells (from ATCC) are a human monocytic cell line which were obtained from the peripheral blood of a one year old male with acute monocytic leukemia. They can be grown in culture and differentiated into macrophage like cells by stimulation with mitogens.

For the assay, THP-1 cells are seeded from an ATCC stock which was previously grown and frozen back at 5×10^6 /ml/vial. One vial is seeded into a T25-flask with 16 mls of RPMI-1640 with glutamax (Gibco) media containing 10 % fetal bovine serum, 100 units/ml penicillin, 100 μ g/ml streptomycin, and 5×10^{-5} M 2-mercapto-ethanol (THP-1 media). Each vial of cells are cultured for about two weeks

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prior to being used for an assay and then are used for only 4 to 6 weeks to screen compounds. Cells are subcultured on Mondays and Thursdays to a concentration of $1 \times 10^5/\text{ml}$.

To perform an assay, the THP-1 cells are co-incubated in a 24 well plate with
5 50 μl /well of a 24 mg/ml stock of Lipopolysaccharide (LPS) (Calbiochem Lot# B13189) at 37°C in 5% CO_2 at a concentration of 1.091×10^6 cells/ ml (1.1 ml /well) for a total of 24 hours. At the same time, 50 μl /well of drug, vehicle or THP-1 media is plated in appropriate wells to give a final volume of 1.2 ml /well. Standard and test compounds are dissolved in DMSO at a concentration of 36 mM and diluted
10 from here to the appropriate concentrations in THP-1 media and added to the wells at the beginning of the incubation period to give final concentrations of 100 mM , 30 mM , 10 mM , 3 mM , 1 mM , 300 nM , and 100 nM . Cell exposure to DMSO was limited to 0.1 % final concentration. Positive control wells were included in the experiment which had mitogen added but no drug. Vehicle control wells were
15 included as well, which were identical to the positive control wells, except that DMSO was added to give a final concentration of 0.083%. Negative control wells were included in the experiment which had vehicle but no mitogen or drug added to the cells. Compounds can be evaluated for their effect on basal (non-stimulated) shedding of the receptors by replacing the LPS with 50 μl /well of THP-1 media.
20 Plates are placed into an incubator set at 5% CO_2 and at 37°C . After 4 hours of incubation, 300 μl /well of tissue culture supernatant (TCS) is removed for use in an TNF- α ELISA. Following 24 hours of incubation, 700 μl /well of TCS is removed and used for analysis in TNF-R p75/80, TNF-R p55/60 and IL-8 ELISAs.

In addition, at the 24 hours timepoint, and the cells for each treatment group
25 are collected by resuspension in 500 μl /well of THP-1 media and transferred into a FACS tube. Two ml /tube of a 0.5 mg/ml stock of propidium iodide (PI) (Boehringer Mannheim cat. # 1348639) is added. The samples are run on a Becton Dickinson FaxCaliber FLOW cytometry machine and the amount of dye taken up by each cell is measured in the high red wavelength (FL3). Only cells with compromised
30 membranes (dead or dying) can take up PI. The percent of live cells is calculated by the number of cells not stained with PI, divided by the total number of cells in the

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sample. The viability values calculated for the drug treated groups were compared to the viability value calculated for the vehicle treated mitogen stimulated group ("vehicle positive control") to determine the "percent change from control". This "percent change from control" value is an indicator of drug toxicity.

5 The quantity of soluble TNF- α , TNF-R p75/80 and TNF-R p55/60 and IL-8 in the TCS of the THP-1 cell cultures are obtained with commercially available ELISAs from R&D Systems, by extrapolation from a standard curve generated with kit standards. The number of cells that either take up or exclude PI are measured by the FLOW cytometry machine and visualized by histograms using commercially
10 available Cytologic software for each treatment group including all controls.

Biological variability in the magnitude of the response of THP-1 cell cultures requires that experiments be compared on the basis of percent change from "vehicle positive control" for each drug concentration. Percent change in each soluble protein evaluated from the "vehicle positive control" was calculated for each compound
15 concentration with the following formula:

$$\% \text{ Change} = \frac{\text{pg/ml (compound)} - \text{pg/ml (veh pos control)}}{\text{pg/ml (veh pos control)} - \text{pg/ml (veh neg control)}} \times 100$$

20 For the soluble protein (TNF- α , p75/80, p55/60, IL-8) studies under stimulated conditions, the mean pg/ml of duplicate wells were determined and the results expressed as percent change from "vehicle positive control". For the soluble protein (p75/80 and p55/60 receptors) studies under non-stimulated conditions, the mean pg/ml of duplicate wells were determined and the results expressed as percent
25 change from "vehicle positive control" utilizing the following formula:

$$\% \text{ Change} = \frac{\text{pg/ml (compound neg control)} - \text{pg/ml (veh neg control)}}{\text{pg/ml (veh neg control)}} \times 100$$

30 IC50 values for each compound are calculated by non-linear regression analysis using customized software utilizing the JUMP statistical package.

For the cell viability studies, the viabilities (PI exclusion) of pooled duplicate wells were determined and the results expressed as % change from "vehicle positive control". The viability values calculated for the compound treated groups were

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compared to the viability value calculated for the "vehicle positive control" to determine "percent change from control" as below. This value "percent change from control" is an indicator of drug toxicity.

$$\% \text{ Change} = \frac{\% \text{ live cells (compound)}}{\% \text{ live cells (veh pos control)}} - 1 \times 100$$

References:

- Bjornberg, F., Lantz, M., Olsson, I., and Gullberg, U. Mechanisms involved in the processing of the p55 and the p75 tumor necrosis factor (TNF) receptors to soluble receptor forms. *Lymphokine Cytokine Res.* 13:203-211, 1994.
- Gatanaga, T., Hwang, C., Gatanaga, M., Cappuccini, F., Yamamoto, R., and Granger, G. The regulation of TNF mRNA synthesis, membrane expression, and release by PMA- and LPS-stimulated human monocytic THP-1 cells in vitro. *Cellular Immun.* 138:1-10, 1991.
- Tsuchiya, S., Yamabe, M., Yamaguchi, Y., Kobayashi, Y., Konno, T., and Tada, K. Establishment and characterization of a human acute monocytic leukemia cell line (THP-1). *Int. J. Cancer.* 26:1711-176, 1980.

- Results of the above in vitro matrix metalloproteinase inhibition, TACE inhibition and THP standard pharmacological test procedures are given in Tables 1-15 below.

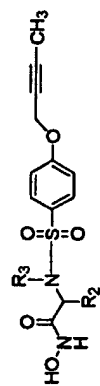
Table 2:

Example #	R ₁	R ₂	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
17	H	Me	1895	309	99	6.8	33
23	H	CH ₂ -3-Pyridyl	1156	40	20	7.2	63
124	H	(CH ₂) ₂ N[(CH ₂) ₂ O]	1768	211	54	13	24
107	Me	Me	330	68	28	4.5	83
33	Me	CH ₂ -3-Pyridyl	239	65	26	5.0	80
135	Me	CH ₂ COCH ₂ N[(CH ₂) ₂] ₂ NMe	921	142	66	21	76
9	iPr	Me	40	11	4.5	7.4	94
108	iPr	Et	92	119	67	33	76
109	iPr	CH ₂ CCH	210	233	53	55	85
110	iPr	Pr	196	477	153	66	47
111	iPr	(CH ₂) ₃ Ph	308	1423	303	481	35
112	iPr	CH ₂ -c-Pr	189	397	142	57	50
113	iPr	CH ₂ CH(CH ₃) ₂	299	918	309	107	0
123	iPr	(CH ₂) ₂ N[(CH ₂) ₂ O]	244	628	89	102	35
118	iPr	(CH ₂) ₃ NEt ₂	121	86	45	154	77
119	iPr	(CH ₂) ₃ N[(CH ₂) ₂ O]	129	94	46	124	61
120	iPr	(CH ₂) ₃ N[(CH ₂) ₂] ₂ NMe	111	211	161	149	61
121	iPr	(CH ₂) ₄ NEt ₂	120	256	114	177	65
122	iPr	(CH ₂) ₄ N[(CH ₂) ₂] ₂ NMe	86	135	50	126	69
114	iPr	CH ₂ -3-Pyridyl	236	193	94	93	75
125	iPr	CH ₂ COCH ₂ N[(CH ₂) ₂] ₂ NMe	505	846	151	108	72
126	iPr	CH ₂ COCH ₂ NEt ₂	212	149	36	73	93
127	iPr	CH ₂ COCH ₂ NHMe	187	53	37	104	83
137	-(CH ₂) ₅	CH ₂ -3-Pyridyl	482	79	48	191	0
115	C ₆ H ₁₁	Me	94	14	6.6	31	89
116	C ₆ H ₁₁	CH ₂ -3-Pyridyl	218	336	53	204	75
117	C ₆ H ₁₁	CH ₂ PhO(CH ₂) ₂ N[(CH ₂) ₂] ₂ NH	74	76	33	274	88
130	C ₆ H ₁₀ -4-OH	Me	169	30	15	23	92
136	-(CH ₂) ₅	Me	682	3753	1629	574	0
128	C ₆ H ₁₀ -4-NEt ₂	Me	2368	184	212	376	51
213	(CH ₂) ₃ SPH-p-Cl	Me	453	--	9.0	210	87

a) IC₅₀ (nM)

b) % Inhibition @ 3 μM

Table 3:



Example #	R ₂	R ₃	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
154	CH ₂ SCH ₃	Me	47	19	5.4	3.3	90
149	C(Me) ₂ SCH ₃	Me	17	13	4.6	29	88
150	C(Me) ₂ SEt	Me	25	20	9.3	51	86
151	C(Me) ₂ SPr	Me	24	31	14	31	82
156	CH ₂ SCH ₂ Ph	Me	70	11	4.5	4.8	75
157	CH ₂ SCH ₂ Ph	CH ₂ -3-Pyridyl	111	32	3.8	98	79
153	C(Me) ₂ SCH ₂ Ph	Me	13	5.5	2.0	160	46
155	CH ₂ SCH ₂ -3-Pyridyl	Me	61	14	4.8	5.9	93
152	C(Me) ₂ SCH ₂ -3-Pyridyl	Me	8.7	3.7	1.7	74	85
140	C(Me) ₂ S(CH ₂) ₂ -N[(CH ₂) ₂] ₂ O	Me	45	103	9.2	86	80
141	C(Me) ₂ S(CH ₂) ₂ -N[(CH ₂) ₂] ₂ NMe	Me	17	8.3	7.6	101	86
142	C(Me) ₂ S(CH ₂) ₂ -NEt ₂	Me	72	10	14	131	89
144	C(Me) ₂ S(CH ₂) ₂ -1-Imidazolyl	Me	16	26	5.9	60	89
145	C(Me) ₂ S(CH ₂) ₂ -NProlineEt	Me	18	7.1	2.5	109	83
143	C(Me) ₂ S(CH ₂) ₃ -NC ₄ H ₉	Me	72	9.5	16	219	86
146	C(Me) ₂ S(CH ₂) ₃ -N[(CH ₂) ₂] ₂ O	Me	13	5.3	3.6	132	84
147	C(Me) ₂ S(CH ₂) ₃ -N[(CH ₂) ₂] ₂ NMe	Me	21	5.3	5.3	157	89
148	C(Me) ₂ S(CH ₂) ₃ -NEt ₂	Me	25	4.8	5.2	88	87

a) IC₅₀ (nM)

b) % Inhibition @ 3 μM

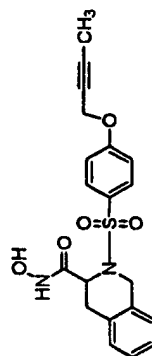
Table 4:

Example #	X	Y	R ₁	R ₂	R ₃	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
17	O	CH	CH ₂ CCCH ₃	H	Me	1895	309	99	6.8	33
133	NH	CH	CH ₂ CCH	H	Me	~10,000	1511	751	120	8
134	S	CH	CH ₂ CCCH ₃	H	Me	4948	111	84	38	14
131	O	N	CH ₂ CCCH ₃	H	Me	~10,000	402	428	29	18
132	O	-	CH ₂ CCPh-4-Cl	H	Me	>10,000	2373	1121	1100	27

a) IC₅₀ (nM)

b) % Inhibition @ 3 μ M

Table 5:

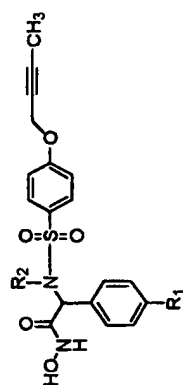


Example #	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
41	121	24	10	7.0	93

a) IC₅₀ (nM)

b) % Inhibition @ 3 μ M

Table 6:

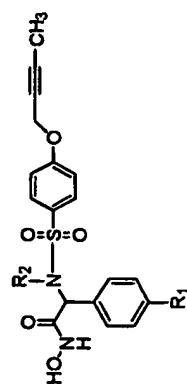


Example #	R ₁	R ₂	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
211	H	Me	496	43	20	8.0	-
176	OH	H	>10,000	898	103	4.0	89
178	OMe	Me	482	43	14	23	91
177	OCH ₂ CCH	H	<10,000	310	57	4.8	64
180	O(CH ₂) ₂ NHBOC	Me	599	34	9.3	265	89
199	O(CH ₂) ₂ NHBOC	H	>10,000	862	139	42	84
201	O(CH ₂) ₂ NHAc	H	>10,000	569	73	9.4	77
181	O(CH ₂) ₂ NH ₂	Me	645	26	24	16	92
200	O(CH ₂) ₂ NH ₂	H	>10,000	518	176	15	78
191	O(CH ₂) ₂ N(Me)BOC	Me	1154	37	60	64	90
192	O(CH ₂) ₂ NHMe	Me	927	11	27	26	95
203	O(CH ₂) ₂ N(Me)BOC	H	>10,000	859	126	49	73
204	O(CH ₂) ₂ NHMe	H	>10,000	349	146	18	73
182	O(CH ₂) ₂ NMe ₂	Me	487	22	15	16	92
207	O(CH ₂) ₂ NMe ₂	H	>10,000	-	112	53	51
208	O(CH ₂) ₂ -4-Thiazolyl-5-Me	H	>10,000	-	230	69	74
212	Cl	Me	798	-	36	62	86

a) IC₅₀ (nM)

b) % Inhibition @ 3μM

Table 7:



Example #	R ₁	R ₂	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	Thp ^b
179	O(CH ₂) ₂ N[(CH ₂) ₂] ₂ O	Me	546	29	11	52	97
206	O(CH ₂) ₂ N[(CH ₂) ₂] ₂ O	H	>10,000	—	147	33	70
185	O(CH ₂) ₂ N[(CH ₂) ₂] ₂ NBOC	Me	839	53	27	309	89
186	O(CH ₂) ₂ N[(CH ₂) ₂] ₂ NH	Me	568	32	21	31	93
183	O(CH ₂) ₂ NC ₄ H ₉	Me	497	55	42	40	93
205	O(CH ₂) ₂ NC ₄ H ₉	H	~10,000	—	146	24	66
188	O(CH ₂) ₃ NH ₂	Me	469	48	41	25	94
187	O(CH ₂) ₃ NHBOC	Me	910	46	13	199	91
184	O(CH ₂) ₂ NC(=O)C ₃ H ₆	Me	434	55	11	35	94
189	O-3-β-PyrrolidineBOC	Me	2437	297	120	231	92
190	O-3-β-PyrrolidineNH	Me	527	37	29	32	94
194	O(CH ₂) ₃ NHAc	Me	592	—	15	61	94
197	O(CH ₂) ₃ NHSO ₂ CH ₃	Me	569	—	24	25	94
196	O(CH ₂) ₃ NHCO ₂ CH ₂ Ph	Me	25% ^a 1	—	31	109	87
193	O(CH ₂) ₃ NHCO ₂ Et	Me	~1000	—	29.3	61	91
198	O(CH ₂) ₃ NHCONHPh	Me	834	—	11	62	92
195	O(CH ₂) ₃ NHCO ₂ nBu	Me	>1000	—	28	122	90
202	O(CH ₂) ₂ N[(CH ₂) ₂] ₂ NBOC	H	>10,000	—	345	113	45
209	O(CH ₂) ₂ O(CH ₂) ₂ O(CH ₂) ₂ OMe	H	~10,000	—	132	39	75
210	O(CH ₂) ₂ O(CH ₂) ₂ OMe	H	>10,000	—	278	17	—

a) IC₅₀ (nM)

b) % Inhibition @ 3 μM

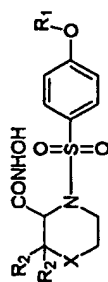
Table 8:

Table 8:

a) IC₅₀ (nM)
b) % Inhibition @ 3μM

Example #	R	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
214	H	676	14	7.6	23	71
56	Me	3344	667	158	41	32
233	CH ₂ Ph-4-Br	2833	69	55	184	33
234	CH ₂ -3-Py	3197	108	49	28	25
224	Ac	357	88	22	13	81
225	COEt	1002	727	230	17	76
230	COCH ₂ NH ₂	8497	1225	410	127	27
229	COCH ₂ NHBOC	1009	322	85	64	85
226	CO-2-Thienyl	498	251	119	12	86
228	COOCH ₃	201	71	9.2	9.0	81
58	BOC	456	24	17	21	79
215	CON[(CH ₂) ₂ O]	695	60	39	35	51
216	CONEt ₂	1752	221	97	28	59
218	CON(iPr) ₂	3291	822	213	49	56
217	CONC ₄ H ₉	1248	209	83	28	73
227	SO ₂ CH ₃	96	51	6.4	7.3	81
220	CON(Me)Ph	1640	561	62	20	60
231	COCH[(CH ₂ O) ₂ CH(CH ₃) ₂]	2448	1115	355	59	73
232	COCH(CH ₂ OH) ₂	1677	785	289	44	72
221	CONHPh-4-OMe	1511	576	182	69	58
222	CONHPh-4-F	941	173	75	30	61
219	CO ₂ CH ₂ Ph	176	45	10	-	87
223	CONHPh-3,5-Cl	1717	642	153	83	42

Table 9:



Example #	X	R ₁	R ₂	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
240	O	CH ₂ CCCH ₃	H	162	170	26	4.5	80
239	S	CH ₂ CCCH ₃	H	148	21	12	2.9	84
258	S	CH ₂ CCH	Me	0.6	--	0.8	19	91
235, 38	S	CH ₂ CCCH ₃	Me	6.6	12	3.0	8.4	94
256	S=O	CH ₂ CCCH ₃	Me	43	145	48	25	92
255	S=O	CH ₂ CCCH ₃	Me	46	29	8.7	24	95
257	SO ₂	CH ₂ CCCH ₃	Me	24	64	23	24	91
259	S	CH ₂ CCCH ₂ CH ₃	Me	5.9	--	5.0	28	92
40	S	CH ₂ CC(CH ₂) ₃ CH ₃	Me	29	7.8	6.6	23	82
236	S	CH ₂ CCCH ₃	-(CH ₂) ₄ -	24	--	11	43	94
237	S	CH ₂ CCCH ₃	-(CH ₂) ₅ -	62	--	12	212	90
241	S	CH ₂ CCCH ₃	-(CH ₂) ₂ NBn(CH ₂) ₂ -	3.1	--	0.5	786	94
238	S	CH ₂ CCCH ₃	Et	38	--	6.8	228	73
242	S	CH ₂ CCCH ₃	-(CH ₂) ₂ NMe(CH ₂) ₂ -	--	--	--	869	73

a) IC₅₀ (nM)b) % Inhibition @ 3 μ M

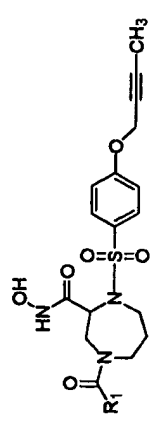
Table 10:

Example #	R ₁	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	Thp ^b
254	CH ₂ CCPh	13	—	11	173	77
263	CH ₂ CCCCH	5.7	—	11	42	88
264	CH ₂ CCCCH ₂ F	11	—	2.5	35	94
61	CH ₂ CCCH ₂ OH	24	70	13	40	89
260	CH ₂ CCCH ₂ OH	33	—	8.1	20	95
261	CH ₂ CCCH ₂ OAc	103	—	1.1	45	92
247	CH ₂ CCCH ₂ OCH ₂ Ph	53	108	2.5	160	57
265	CH ₂ CCCH ₂ NH ₂	97	8.7	7.5	67	40
266	CH ₂ CCCH ₂ NHBOC	26	31	4.0	74	79
267	CH ₂ CCCH ₂ N(Me)BOC	364	1265	37	112	15
244	CH ₂ CC(CH ₂) ₂ OH	35	72	14	62	57
246	CH ₂ CC(CH ₂) ₂ NH ₂	1052	41	27	138	4
245	CH ₂ CC(CH ₂) ₂ NHBOC	300	2384	6.6	112	37
243	CH ₂ CC(CH ₂) ₂ OTHP	194	178	4.1	87	52
248	CH ₂ CC(CH ₂) ₃ OTHP	98	48	7.3	92	21
249	CH ₂ CC(CH ₂) ₃ OH	159	377	86	40	51
251	CH ₂ CC(CH ₂) ₃ NH ₂	226	28	8.7	28	22
250	CH ₂ CC(CH ₂) ₃ NHBOC	42	160	1.7	153	27
262	CH ₂ CCCCCH ₂ OH	9.9	—	14	39	81
252	CH ₂ CC(CH ₂) ₄ NHBOC	87	—	4.3	199	70
253	CH ₂ CC(CH ₂) ₄ NH ₂	92	—	7.3	40	37
268	CH ₂ CC(CH ₂) ₄ OAc	29	—	2.9	78	76
269	CH ₂ CC(CH ₂) ₄ OH	101	—	17	53	77

a) IC₅₀ (nM)

b) % Inhibition @ 3μM

Table 12:

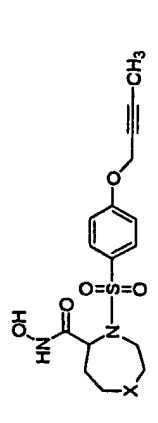


Example #	R ₁	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
49	Ph	362	75	65	17	32

a) IC₅₀ (nM)

b) % Inhibition @ 3μM

Table 13:

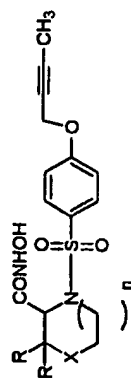


Example #	X	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
290	NCH ₂ Ph	287	25	7.5	83	45
292	NH	274	--	33	24	83
293	NMe	238	--	21	23	82
291	NBOC	92	--	5.4	74	75
289	NCOPh	113	12	4.0	10	93
294	S	--	--	--	13	87

a) IC₅₀ (nM)

b) % Inhibition @ 3μM

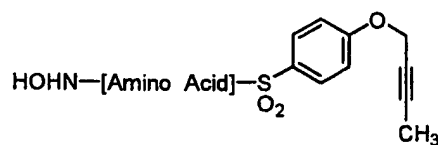
Table 14:



Example #	X	n	R	MMP-1 ^a	MMP-9 ^a	MMP-13 ^a	TACE ^a	THP ^b
286	S	0	Me	3036	1794	852	20	73
173	S	2	Me	20	-	16	111	80
174	S	2	H	408	-	36	20	80
175	SO ₂	2	H	1027	-	50	28	83

a) IC₅₀ (nM)b) % Inhibition @ 3 μ M

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Table 15: In Vitro Inhibition of TACE

Example	% Inhibition at 1 uM	IC 50 nM
62B	46.2	
63	47.6	
64	67.4	420 ± 50
65	102	398± 136
66	45.6	
67	46.2	
68	70.4	885
69	48.5	
70	21.1	
71	86.7	402± 55
72	57.4	550
73	79	451± 31
74	73.8	297± 119
75	55.8	387
76	29.7	
77	105	6.9± 3.3
78	101	11.8± 4.6
79	107	5.7± 2.5
80	105	10.8± 3.7
81	106	4.99± 1.1
82	98.4	7.1
83	105	45.1± 9.5
84	100.7	7.8± 0.4
85	102	8.3± 2.7
86	37.5	
87	47.8	
88	8.4	
89	56.8	
90	58.9	462± 58
91	95	328± 38
92	101.5	490± 139
93	61.7	546
94	38.2	
95	98.6	120
96	22	
97	67.5	283± 42
98	2.5	
99	28.5	
100	15.4	
101	30.2	

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Example	% Inhibition at 1 uM	IC 50 nM
102	27.3	
103	52.8	
104	38.5	
295		29.3
296		10.9
297		10.9
298	40	
299		10.4
300		11
301		24.6
302	3	
303		27.4
304		28.9
305		13.4
306		8.7
307		29.4
308		29.5
309		11.4
310		27.9
311		15.7
312		4.7
313		6.3
314		25
315		5.7
316		4
317		6.5
318		11.9
319		10.5
320		7.4
321		4.7
322		11.8
323		17.6
324		14.7
325		6.9
326		58.6
327		5.5
328		6.26
329		6.88
330		3.58
331		5.32
332		5.13
333		4.21
334		4.7
335		6.5
336		6.11
337		4.2
338		3.73
339		4.6
340		6.67

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Example	% Inhibition at 1 uM	IC 50 nM
341		4.88
342		4.54
343		3.54
344		5.24
345		4.43
346		4.63
347		3.15
348		6.25
349		9.41
350		6.28
351		9.57
352		4.96
353		6.1
354		5.89
355		12.38
356		9.36
357		14.13
358		8.84
359		9.28
360		4.97
361		6.32
362		4.55
363		3.39
364		7.79
365		14.63
366		106
367		38
368		151
369		14.2
370		2.4
371		377
372		8.4
373		16.9
374		18.2
375		24.6
376		21.9
377		26.5
378		22.8

Based on the results obtained in the standard pharmacological test procedures described above, the compounds of this invention were shown to be inhibitors of the enzymes MMP-1, MMP-9, MMP-13 and TNF- α converting enzyme (TACE) and are therefore useful in the treatment of disorders such as arthritis, tumor metastasis, tissue ulceration, abnormal wound healing, periodontal disease, graft rejection, insulin resistance, bone disease and HIV infection.

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The compounds of this invention are also useful in treating or inhibiting pathological changes mediated by matrix metalloproteinases such as atherosclerosis, atherosclerotic plaque formation, reduction of coronary thrombosis from atherosclerotic plaque rupture, restenosis, MMP-mediated osteopenias, inflammatory diseases of the central nervous system, skin aging, angiogenesis, tumor metastasis, tumor growth, osteoarthritis, rheumatoid arthritis, septic arthritis, corneal ulceration, proteinuria, aneurysmal aortic disease, degenerative cartilage loss following traumatic joint injury, demyelinating diseases of the nervous system, cirrhosis of the liver, glomerular disease of the kidney, premature rupture of fetal membranes, inflammatory bowel disease, age related macular degeneration, diabetic retinopathy, proliferative vitreoretinopathy, retinopathy of prematurity, ocular inflammation, keratoconus, Sjogren's syndrome, myopia, ocular tumors, ocular angiogenesis/-neovascularization and corneal graft rejection.

Compounds of this invention may be administered neat or with a pharmaceutical carrier to a patient in need thereof. The pharmaceutical carrier may be solid or liquid.

Applicable solid carriers can include one or more substances which may also act as flavoring agents, lubricants, solubilizers, suspending agents, fillers, glidants, compression aids, binders or tablet-disintegrating agents or an encapsulating material. In powders, the carrier is a finely divided solid which is in admixture with the finely divided active ingredient. In tablets, the active ingredient is mixed with a carrier having the necessary compression properties in suitable proportions and compacted in the shape and size desired. The powders and tablets preferably contain up to 99% of the active ingredient. Suitable solid carriers include, for example, calcium phosphate, magnesium stearate, talc, sugars, lactose, dextrin, starch, gelatin, cellulose, methyl cellulose, sodium carboxymethyl cellulose, polyvinylpyrrolidone, low melting waxes and ion exchange resins.

Liquid carriers may be used in preparing solutions, suspensions, emulsions, syrups and elixirs. The active ingredient of this invention can be dissolved or suspended in a pharmaceutically acceptable liquid carrier such as water, an organic solvent, a mixture of both or pharmaceutically acceptable oils or fat. The liquid

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carrier can contain other suitable pharmaceutical additives such as solubilizers, emulsifiers, buffers, preservatives, sweeteners, flavoring agents, suspending agents, thickening agents, colors, viscosity regulators, stabilizers or osmo-regulators. Suitable examples of liquid carriers for oral and parenteral administration include

5 water (particularly containing additives as above, e.g., cellulose derivatives, preferable sodium carboxymethyl cellulose solution), alcohols (including monohydric alcohols and polyhydric alcohols, e.g., glycols) and their derivatives, and oils (e.g., fractionated coconut oil and arachis oil). For parenteral administration the carrier can also be an oily ester such as ethyl oleate and isopropyl myristate. Sterile liquid

10 carriers are used in sterile liquid form compositions for parenteral administration.

Liquid pharmaceutical compositions which are sterile solutions or suspensions can be utilized by, for example, intramuscular, intraperitoneal or subcutaneous injection. Sterile solutions can also be administered intravenously. Oral administration may be either liquid or solid composition form.

15 The compounds of this invention may be administered rectally in the form of a conventional suppository. For administration by intranasal or intrabronchial inhalation or insufflation, the compounds of this invention may be formulated into an aqueous or partially aqueous solution, which can then be utilized in the form of an aerosol. The compounds of this invention may also be administered transdermally

20 through the use of a transdermal patch containing the active compound and a carrier that is inert to the active compound, is non-toxic to the skin, and allows delivery of the agent for systemic absorption into the blood stream via the skin. The carrier may take any number of forms such as creams and ointments, pastes, gels, and occlusive devices. The creams and ointments may be viscous liquid or semi-solid emulsions of

25 either the oil in water or water in oil type. Pastes comprised of absorptive powders dispersed in petroleum or hydrophilic petroleum containing the active ingredient may also be suitable. A variety of occlusive devices may be used to release the active ingredient into the blood stream such as a semipermeable membrane covering a reservoir containing the active ingredient with or without a carrier, or a matrix

30 containing the active ingredient. Other occlusive devices are known in the literature.

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The dosage to be used in the treatment of a specific patient suffering a MMP or TACE dependent condition must be subjectively determined by the attending physician. The variables involved include the severity of the dysfunction, and the size, age, and response pattern of the patient. Treatment will generally be initiated
5 with small dosages less than the optimum dose of the compound. Thereafter the dosage is increased until the optimum effect under the circumstances is reached. Precise dosages for oral, parenteral, nasal, or intrabronchial administration will be determined by the administering physician based on experience with the individual subject treated and standard medical principles.

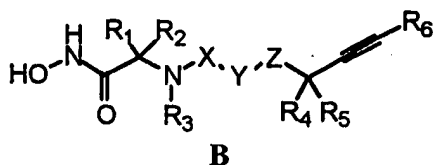
10 Preferably the pharmaceutical composition is in unit dosage form, e.g., as tablets or capsules. In such form, the composition is sub-divided in unit dose containing appropriate quantities of the active ingredient; the unit dosage form can be packaged compositions, for example packed powders, vials, ampoules, prefilled syringes or sachets containing liquids. The unit dosage form can be, for example, a
15 capsule or tablet itself, or it can be the appropriate number of any such compositions in package form.

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CLAIMS

5

1. A compound having having the formula:



wherein:

10

X is SO₂ or -P(O)-R₁₀;

Y is aryl or heteroaryl, with the proviso that X and Z may not be bonded to adjacent atoms of Y;

Z is O, NH, CH₂ or S;

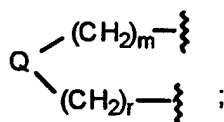
15

R₁ is hydrogen, aryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

R₂ is hydrogen, aryl, aralkyl, heteroaryl, heteroaralkyl, cycloalkyl of 3-6 carbon atoms, C₄-C₈ cycloheteroalkyl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

20

or R₁ and R₂, together with the atom to which they are attached, may form a ring wherein R₁ and R₂ represent a divalent moiety of the formula:



wherein

Q = a carbon-carbon single or double bond, O, S, SO, SO₂, -N-R₁₁, or -CONR₁₄;

25

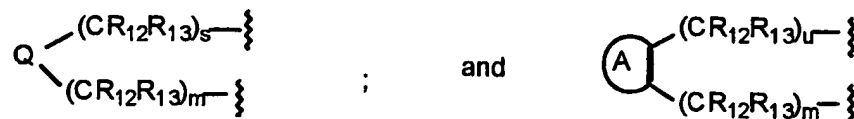
m = 1-3;

r = 1 or 2, with the proviso that when Q is a bond, r is equal to 2;

R₃ is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, C₄-C₈ cycloheteroalkyl, aralkyl, or heteroaralkyl;

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or R_1 and R_3 , together with the atoms to which they are attached, may form a 5 to 8 membered ring wherein R_1 and R_3 represent divalent moieties of the formulae:



5 wherein Q and m are as defined above;

A is aryl or heteroaryl;

s is 0-3;

u is 1-4;

10 R_4 and R_5 are each, independently, hydrogen or alkyl of 1-6 carbon atoms, -CN, or -CCH;

R_6 is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, or -C₅-C₈-cycloheteroalkyl;

15 R_8 and R_9 are each, independently, hydrogen, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, aralkyl, heteroaryl, heteroaralkyl, or -C₄-C₈-cycloheteroalkyl;

R_{10} is alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl or heteroaryl;

20 R_{11} is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -S(O)_nR₈, -COOR₈, -CONR₈R₉, -SO₂NR₈R₉ or -COR₈;

25 R_{12} and R_{13} are independently selected from H, -OR₈, -NR₈R₉, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -COOR₈, -CONR₈R₉; or R_{12} and R_{13} together form a -C₃-C₆-cycloalkyl of 3-6 carbon atoms or a -C₅-C₈-cycloheteroalkyl ring; or R_{12} and R_{13} , together with the carbon to which they are attached, form a carbonyl group;

30 with the proviso that R_{10} and R_{12} or R_{11} and R_{12} may form a cycloheteroalkyl ring when they are attached to adjacent atoms;

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R_{14} is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms or cycloalkyl of 3-6 carbon atoms;

and n is 0-2;

or a pharmaceutically acceptable salt thereof.

5

2. A compound according to Claim 1 wherein Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, or a pharmaceutically acceptable salt thereof.

10

3. A compound according to Claim 1 or Claim 2 wherein X is SO_2 , or a pharmaceutically acceptable salt thereof.

4. A compound according to any one of Claims 1 to 3 wherein Z is oxygen, or a pharmaceutically acceptable salt thereof.

15

5. A compound according to any one of Claims 1 to 4 wherein R_4 and R_5 are hydrogen, or a pharmaceutically acceptable salt thereof.

6. A compound according to any one of Claims 1 to 5 wherein R_6 is -
20 CH_2OH or methyl, or a pharmaceutically acceptable salt thereof.

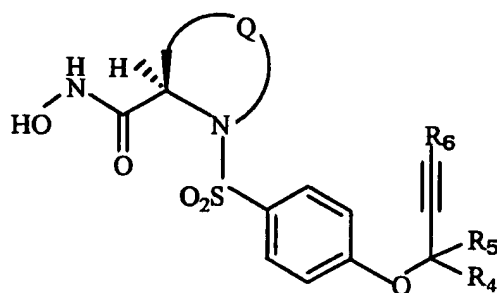
7. A compound according to any one of Claims 1 to 6 wherein R_1 and R_3 , together with the atoms to which they are attached, form a piperazine, piperidine, tetrahydroisoquinoline, morpholine, thiomorpholine, or diazepine ring.

25

8. A compound according to any one of Claims 1 to 7 wherein R^2 is hydrogen.

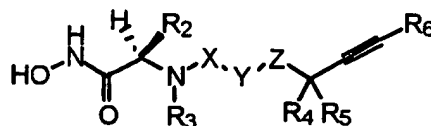
9. A compound according to Claim 8 wherein R_2 is hydrogen such that
30 structure B has the absolute stereochemistry shown below,

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or a pharmaceutically acceptable salt thereof.

10. A compound according to any one of Claims 1 to 6 wherein R_1 is hydrogen, such that this compound has the D-configuration, as shown below:



11. A compound according to Claim 10 wherein R_3 is hydrogen, or a pharmaceutically acceptable salt thereof.

12. A compound according to Claim 10 wherein R_3 is hydrogen, Y is a phenyl ring substituted at the 1- and 4-positions by X and Z, respectively, X is SO_2 , and Z is oxygen, or a pharmaceutically acceptable salt thereof.

13. A compound according to Claim 1 which is selected from the group consisting of:

2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-butamide;

2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-acetamide;

N-Hydroxy-2-[(4-methoxy-benzenesulfonyl)-methyl-amino]-3-methyl-butamide;

2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-acetamide hydrochloride;

2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-acetamide;

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- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-methyl-butyramide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 5 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-propionamide hydrochloride;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-methyl-propionamide;
- 10 4-(4-But-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 15 4-(4-Hept-2-ynyloxy-benzenesulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonyl)-1,2,3,4-tetrahydro-isoquinoline-3-carboxylic acid hydroxyamide;
- 20 4-Benzoyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-[1,4]diazepane-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methyl-piperazine-2-carboxylic acid hydroxyamide hydrochloride;
- 25 4-[4-(4-Hydroxy-but-2-ynyloxy)-benzenesulfonyl]-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 30 4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid tert-butyl ester;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-methyl-propionamide;
- 35 2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-guanidino-pentanoic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-(4-methylbenzenesulfonyl-guanidino)-pentanoic acid hydroxyamide;
- 40 3-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-succinamic acid cyclohexyl ester;
- 45 2-(4-But-2-ynyloxy-benzenesulfonylamino)-3-cyclohexyl-N-hydroxy-propionamide;

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- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-2-cyclohexyl-N-hydroxy-acetamide;
- 5 3-tert-Butylsulfanyl-2-(4-but-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(4-methoxy-benzylsulfanyl)-propionamide;
- 10 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N1-hydroxy-succinamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-3-cyclohexyl-N-hydroxy-propionamide;
- 15 2-(4-But-2-ynyloxy-benzenesulfonylamino)-2-cyclohexyl-N-hydroxy-acetamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-4-methyl-pentanoic acid hydroxyamide;
- 20 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-4-methylsulfanyl-butyramide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-phenyl-propionamide
- 25 1-(4-But-2-ynyloxy-benzenesulfonyl)-pyrrolidine-2-carboxylic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(1H-indol-3-yl)-propionamide;
- 30 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-(4-hydroxy-phenyl)-propionamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-3-methyl-butyramide;
- 35 2-(4-But-2-ynyloxy-benzenesulfonylamino)-4-methyl-pentanoic acid hydroxyamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-6-(2-chloro-benzylamino)-hexanoic acid hydroxyamide;
- 40 2-(4-But-2-ynyloxy-benzenesulfonylamino)-hexanoic acid hydroxyamide;
- 45 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-2-phenyl-acetamide;

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- 3-Benzyloxy-2-(4-but-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-propionamide;
- 2-(4-But-2-ynyloxy-benzenesulfonylamino)-N-hydroxy-acetamide;
- 5 (2R,3S)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-methylpentanamide;
- (2R)-2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3,3-dimethylbutanamide;
- 10 (2S)-2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-N-hydroxy-propionamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-ethyl-amino]-N-hydroxy-3-methyl-butylamide;
- 15 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(2-propynyl)amino]-N-hydroxy-3-methylbutanamide;
- 20 2-[(4-But-2-ynyloxy-benzenesulfonyl)-propyl-amino]-N-hydroxy-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-(3-phenyl-propyl)-amino]-N-hydroxy-3-methyl-butylamide;
- 25 2-[(4-But-2-ynyloxy-benzenesulfonyl)-cyclopropylmethyl-amino]-N-hydroxy-3-methyl-butylamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-isobutyl-amino]-N-hydroxy-3-methyl-butylamide;
- 30 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-N-hydroxy-3-methyl-butylamide;
- 35 2-[(4-But-2-ynyloxy-benzenesulfonyl)-methyl-amino]-2-cyclohexyl-N-hydroxy-acetamide;
- 2-[(4-But-2-ynyloxy-benzenesulfonyl)-pyridin-3-ylmethyl-amino]-2-cyclohexyl-N-hydroxy-acetamide;
- 40 2-{(4-But-2-ynyloxy-benzenesulfonyl)-[4-(2-piperidin-1-yl-ethoxy)-benzyl]-amino}-2-cyclohexyl-N-hydroxy-acetamide;
- 45 2-{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(diethylamino)propyl]amino}-N-hydroxy-3-methylbutanamide;

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- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-morpholinyl)propyl]amino}-N-hydroxy-3-methylbutanamide;
- 5 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[3-(4-methyl-1-piperazinyl)propyl]amino}-N-hydroxy-3-methylbutanamide hydrochloride;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)butyl]amino}-N-hydroxy-3-methylbutanamide;
- 10 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)butyl]amino}-N-hydroxy-3-methylbutanamide;
- 2-[[[4-(2-Butynyloxy)phenyl]sulfonyl][2-(4-morpholinyl)ethyl]amino]-N-hydroxy-3-methylbutanamide;
- 15 2-[[[4-(2-Butynyloxy)phenyl]sulfonyl][2-(4-morpholin-4-ylethyl)amino]-N-hydroxyacetamide hydrochloride;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 20 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(diethylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(methylamino)-2-butynyl]amino}-N-hydroxy-3-methylbutanamide;
- 25 ((2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino})[(4-diethylamino)-cyclohexyl]-N-hydroxyethamide;
- 30 (2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}amino}-N-hydroxy-2-(4-hydroxycyclohexyl)ethanamide;
- (2R)-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino}-N-hydroxy-2-(4-hydroxycyclohexyl)-ethanamide;
- 35 2-[(6-But-2-ynyloxy-pyridine-3-sulfonyl)-methyl-amino]-N-hydroxy-acetamide;
- 2-[[[4-(3-(4-Chlorophenyl)-2-propynyl]oxy)phenyl]sulfonyl](methyl)amino]-N-hydroxyacetamide;
- 40 N-Hydroxy-2-(methyl{[4-(prop-2-ynylamino)phenyl]sulfonyl}amino)acetamide;
- 2-[(4-But-2-ynylthiophenylsulfonyl)methylamino]-N-hydroxyacetamide;
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- 2-{{[4-(2-Butynyloxy)phenyl]sulfonyl}[4-(4-methyl-1-piperazinyl)-2-yl][4-(4-methyl-1-piperazinyl)-2-butynyl]amino}-N-hydroxypropanamide;
- 5 1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-sulfonyl}(methyl)-amino]-N-hydroxycyclohexanecarboxamide;
- 1-{{[4-(2-Butynyloxy)phenyl]sulfonyl}(3-pyridinylmethyl)amino]N-hydroxy-cyclohexanecarboxamide;
- 10 1-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxycyclohexanecarboxamide;
- 1-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxycyclopentanecarboxamide;
- 15 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[(2-(4-morpholinylethyl)sulfanyl]-butanamide hydrochloride;
- 2-([4-(2-Butynyloxy)phenyl] sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2-(4-methyl-1-ethyl-1-piperazinyl)ethyl]sulfanyl]butanamide;
- 20 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2-(diethylamino)ethyl]sulfanyl]butanamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2-(1-pyrrolidinyl)ethyl]sulfanyl]butanamide;
- 25 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2-(1H-imidazol-1-yl)ethyl]sulfanyl]butanamide;
- 30 Methyl 1-[2-([2-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)]amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl]sulfanyl]ethyl]-2-pyrrolidinecarboxylate;
- 35 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[(2(4-morpholinylpropyl)sulfanyl]-butanamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2(4-methyl-1-ethyl-1-piperazinyl)propyl]sulfanyl]butanamide;
- 40 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino]-N-hydroxy-3-methyl-3-[[2-(diethylamino)propyl]sulfanyl]butanamide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-methylsulfanyl-butyramide;
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- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butyramide;
- 5 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-(pyridin-3-ylmethylsulfanyl)-butyramide;
- 10 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-methyl-3-benzylsulfanyl-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(methylsulfanyl)-butyramide;
- 15 2-[(4-But-2-ynyloxy-benenesulfonyl)-methyl-amino]-N-hydroxy-3-(pyridin-3-ylmethylsulfanyl)-butyramide;
- 3-(Benzylthio)-2-[[[4-(2-butynyloxy)phenyl]sulfonyl]methylamino]-N-hydroxypropanamide;
- 20 3-(Benzylthio)-2-[[[4-(2-butynyloxy)phenyl]sulfonyl]pyridin-3-ylmethylamino]-N-hydroxypropanamide;
- 25 2-[[[4-(2-Butynyloxy-phenyl)sulfonyl]amino]-N-hydroxy-3-methyl-(3-methylthio)-butyramide;
- 2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-ethylsulfanyl-butyramide;
- 30 2-[(4-But-2-ynyloxy-benenesulfonyl)-amino]-N-hydroxy-3-methyl-3-propylsulfanyl-butyramide;
- 2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-methyl-[(3-pyridinylmethyl)thio] butyramide;
- 35 2-[(4-Butynyloxy-phenyl)sulfonyl]-amino]-N-hydroxy-3-methyl-(3-benzylsulfanyl) butyramide;
- 40 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino-N-hydroxy-3-{[(-methyl-1H-imidazol-2-yl)methylsulfanyl]}butanamide;
- 2-([4-(2-butynyloxy)phenyl]sulfonyl)amino-N-hydroxy-3-methyl-3-{[2-(4-morpholinyl) ethyl]sulfanyl}butanamide;
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- tert*-Butyl{[2-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl]sulfanyl}acetate;
- 5 *tert*-Butyl{[2-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-3-(hydroxyamino)-1,1-dimethyl-3-oxopropyl]sulfanyl}acetic acid, sodium salt;
- 2-[(4-Butynyloxy-phenylsulfonyl)-amino]-N-hydroxy-3-(methylthio)propanamide;
- 10 2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(benzylthio)propanamide;
- 2-[[4-Butynyloxy-phenylsulfonyl]-amino]-N-hydroxy-3-(pyridinylthio)propanamide;
- 15 2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-3-[(Z)-11-tetradecenylsulfanyl]propanamide;
- 20 (2S)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-methylbutanamide;
- (2S)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-3-[(3-hydroxypropyl)sulfanyl]-3-propanamide;
- 25 (3S)-4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-1,4-thiazepane-3-carboxamide;
- (3S)-4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-thiazepane-3-carboxamide;
- 30 (3S)-4-({[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-thiazepane-3-carboxamide 1,1-dioxide;
- 2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-(4-hydroxyphenyl)acetamide;
- 35 2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-[4-(2-propynyloxy)phenyl]acetamide;
- 40 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-(4-methoxyphenyl)acetamide;
- 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methylamino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide;
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- tert*-Butyl 2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate;
- 5 2-[4-(2-Aminoethoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-N-hydroxyacetamide;
- 2-[{{4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-2-{4-[2-(dimethylamino)-ethoxy]phenyl}-N-hydroxyacetamide;
- 10 2-[[{4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- 2-[{{4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[2-(2-oxo-1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- 15 *tert*-Butyl 4-(2-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-1-piperazinecarboxylate;
- 20 2-[[{4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[2-(1-piperazinyl)ethoxy]phenyl}acetamide;
- tert*-Butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 25 2-[4-(3-Aminopropoxy)phenyl]-2-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-N-hydroxyacetamide;
- tert*-Butyl (3S)-3-{4-[(1R)-1-[[4-(2-butynyloxy)phenyl]sulfonyl]-(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}-1-pyrrolidinecarboxylate;
- 30 (2R)-2-[[{4-(2-Butynyloxy)phenyl]sulfonyl}(methyl)amino]-N-hydroxy-2-{4-[(3S)-pyrrolidinyl]phenyl}ethanamide;
- 35 *tert*-Butyl (2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)(methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-(methyl)carbamate;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methyl)amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide;
- 40 Ethyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 2-{4-[3-(Acetylamino)propoxy]phenyl}-2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxyacetamide;
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- Butyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 5 Benzyl 3-{4-[1-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}propylcarbamate;
- 2-[[4-(2-Butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxy-2-(4-{3-[(methylsulfonyl)amino]propoxy}phenyl)acetamide;
- 10 2-(4-{3-[(Anilincarbonyl)amino]propoxy}phenyl)-2-[[4-(2-butynyloxy)phenyl]sulfonyl](methyl)amino]-N-hydroxyacetamide;
- tert*-Butyl 2-{4-[(1R)-1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethylcarbamate;
- 15 (2R)-2-[4-(2-Aminoethoxy)phenyl]-2-([4-(2-butynyloxy)phenyl]-sulfonyl)amino)-N-hydroxyethanamide;
- (2R)-2-{4-[2-(Acetylamino)ethoxy]phenyl}-2-([4-(2-butynyloxy)phenyl]-sulfonyl)amino)-N-hydroxyethanamide;
- 20 *tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-1-piperazinecarboxylate;
- 25 *tert*-Butyl 4-(2-{4-[1-([4-(2-butynyloxy)phenyl]sulfonyl)amino]-2-(hydroxyamino)-2-oxoethyl]phenoxy}ethyl)-(methyl)carbamate;
- 2-{[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-2-{4-[2-(methylamino)ethoxy]phenyl}acetamide;
- 30 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(1-pyrrolidinyl)ethoxy]phenyl}acetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-morpholinyl)ethoxy]phenyl}acetamide;
- 35 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino){4-[2-(dimethylamino)-ethoxy]phenyl}-N-hydroxyacetamide;
- 40 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(4-methyl-1,3-thiazol-5-yl)ethoxy]phenyl}acetamide;
- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-(4-{2-[2-(2-thoxyethoxy)ethoxy]ethoxy}phenyl)acetamide;
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- 2-([4-(2-Butynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-{4-[2-(2-methoxyethoxy)ethoxy]phenyl}acetamide;
- 5 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-N-hydroxy-2-phenylacetamide;
- 2-[4-(2-Butynyloxy)phenyl]sulfonyl(methylamino)-2-(4-chlorophenyl)-N-hydroxyacetamide;
- 10 2-([4-(2-Butynyloxy)phenyl]sulfonyl)(methylamino)-5-[(4-chlorophenyl)sulfonyl]-N-hydroxypentanamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 15 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(morpholine-4-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diethylamide 3-hydroxyamide;
- 20 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(pyrrolidine-1-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 25 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 1-diisopropylamide 3-hydroxyamide;
- Benzyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-3-[(hydroxyamino)carbonyl]-1-piperazinecarboxylate;
- 30 4-(4-But-2-ynyloxy-benzenesulfonyl)-piperazine-1,3-dicarboxylic acid 3-hydroxyamide 1-(methyl-phenyl-amide);
- 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-3-hydroxy-N-1-(4-methoxyphenyl)-1,3-piperazinedicarboxamide;
- 35 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-1-(4-fluorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide;
- 40 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-1-(3,5-dichlorophenyl)-N-3-hydroxy-1,3-piperazinedicarboxamide;
- 4-(Acetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
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- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-propionyl-piperazine-2-carboxylic acid hydroxyamide;
- 5 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-(thiophene-2-carbonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-methanesulfonyl-piperazine-2-carboxylic acid hydroxyamide;
- 10 4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazine-1-carboxylic acid methyl ester;
- {2-[4-(4-But-2-ynyloxy-benzenesulfonyl)-3-hydroxycarbamoyl-piperazin-1-yl]-2-oxo-ethyl}-carbamic acid *tert*-butyl ester;
- 15 4-Aminoacetyl-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-4-[(2,2,5-trimethyl-1,3-dioxan-5-yl)carbonyl]-2-piperazinecarboxamide;
- 20 1-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-4-[3-hydroxy-2-(hydroxymethyl)-2-methylpropanoyl]-2-piperazinecarboxamide;
- 25 4-(4-Bromo-benzyl)-1-(4-but-2-ynyloxy-benzenesulfonyl)-piperazine-2-carboxylic acid hydroxyamide;
- 1-(4-But-2-ynyloxy-benzenesulfonyl)-4-pyridin-3-ylmethyl-piperazine-2-carboxylic acid hydroxyamide;
- 30 (3S)-4-({[4-(2-Butynyloxy)phenyl}sulfonyl)-2,2-dimethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 9-({[4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-6-thia-9-azaspiro[4,5]decane-10-carboxamide;
- 35 9-({[4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-1-thia-4-azaspiro[5,5]undecane-5-carboxamide;
- 40 4-({[4-(2-Butynyloxy)phenyl}sulfonyl)-2,2-diethyl-thiomorpholine-3-carboxylic acid hydroxyamide;
- 4-({[4-(2-Butynyloxy)phenyl}sulfonyl)-N-hydroxy-thiomorpholine-3-carboxamide;
- 45 4-([4-(2-Butynyloxy)phenyl]sulfonyl)-N-hydroxy-3-morpholinecarboxamide;

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- 9-Benzyl-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide;
- 5 9-Methyl-4-{{4-(2-butynyloxy)phenyl}sulfonyl}-N-hydroxy-1-thia-4,9-diazaspiro[5.5]undecane-5-carboxamide;
- 10 N-Hydroxy-2,2-dimethyl-4-[(4-{{5-(tetrahydro-2H-pyran-2-yloxy)-2-pentynyl}oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide;
- N-Hydroxy-4-({4-[(5-hydroxy-2-pentynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 15 *tert*-Butyl 5-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl)phenoxy]-3-pentynylcarbamate;
- 4-({4-[(5-Amino-2-pentynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 20 4-[(4-{{4-(Benzyloxy)-2-butynyl}oxy}phenyl)sulfonyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- N-Hydroxy-2,2-dimethyl-4-[(4-{{6-(tetrahydro-2H-pyran-2-yloxy)-2-hexynyl}oxy}phenyl)sulfonyl]-3-thiomorpholine carboxamide;
- 25 N-Hydroxy-4-({4-[(6-hydroxy-2-hexynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 30 *tert*-Butyl 6-[4-({(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-4-hexynylcarbamate;
- (3S)-4-({4-[(6-Amino-2-hexynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 35 *tert*-Butyl 7-[4-({(3S)-3-[(hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}sulfonyl)phenoxy]-5-heptynylcarbamate;
- (3S)-4-({4-[(7-Amino-2-heptynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 40 (3S)-N-Hydroxy-2,2-dimethyl-4-({4-[(3-phenyl-2-propynyl)oxy]phenyl}sulfonyl)-3-thiomorpholine carboxamide;
- 45 (3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide (1S)-oxide;

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- (3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide (1R)-oxide;
- 5 (3S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide 1,1-dioxide;
- (3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2-propynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide;
- 10 (3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2-pentynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide;
- (3S)-N-Hydroxy-4-({4-[(4-hydroxy-2-butynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 15 4-[4-({(3S)-3-[(Hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}-sulfonyl)phenoxy]-2-butynyl acetate;
- (3S)-N-Hydroxy-4-({4-[(6-hydroxy-2,4-hexadiynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholine carboxamide;
- 20 (3S)-N-Hydroxy-2,2-dimethyl-4-{{4-(2,4-pentadiynyloxy)phenyl}sulfonyl}-3-thiomorpholine carboxamide;
- 25 (3S)-4-({4-[(4-Fluoro-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 4-({4-[(4-Amino-2-butynyl)oxy]phenyl}sulfonyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholine carboxamide;
- 30 *tert*-Butyl 4-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl)phenoxy]-2-butynylcarbamate;
- tert*-Butyl 4-[4-({3-[(hydroxyamino)carbonyl]-2,2-dimethyl-4-thiomorpholinyl}sulfonyl)phenoxy]-2-butynyl(methyl)carbamate;
- 35 7-[4-({(3S)-3-[(Hydroxyamino)carbonyl]-2,2-dimethylthiomorpholinyl}-sulfonyl)phenoxy]-5-heptynyl acetate;
- 40 (3S)-N-Hydroxy-4-({4-[(7-hydroxy-2-heptynyl)oxy]phenyl}sulfonyl)-2,2-dimethyl-3-thiomorpholinecarboxamide;
- (3S,5S)-4-{{4-(2-Butynyloxy)phenyl}sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide;
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- (3S,5R)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,5-trimethyl-3-thiomorpholinecarboxamide;
- 5 (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2,6-trimethyl-3-thiomorpholinecarboxamide;
- tert*-Butyl{(2R,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl} methylcarbamate;
- 10 *tert*-Butyl{(2S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl} methylcarbamate;
- (3S,6R)-Trans-6-(aminomethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride;
- 15 (3S,6S)-Cis-6-(aminomethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide hydrochloride;
- tert*-Butyl{(2S,5S)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl} acetate;
- 20 {(2S,5S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-6,6-dimethylthiomorpholinyl} acetic acid;
- (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-6-[2-(hydroxyamino)-2-oxoethyl]-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 25 (3S,6S)-6-(2-Amino-2-oxoethyl)-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- 30 (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-[2-(dimethylamino)-2-oxoethyl]-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-morpholinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide;
- 35 (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-6-[2-(4-methyl-1-piperazinyl)-2-oxoethyl]-3-thiomorpholinecarboxamide hydrochloride;
- 40 (3S,6S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-6-(2-{[2-(dimethylamino)ethyl]-amino}-2-oxoethyl)-N-hydroxy-2,2-dimethyl-3-thiomorpholinecarboxamide;
- Methyl (3S,6S)-6-{{[(*tert*-butoxycarbonyl)amino]methyl}-4-{{[4-(2-butynyloxy)phenyl]sulfonyl}-2,2-dimethyl-3-thiomorpholinecarboxylate;
- 45

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- (4S)-3-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-5,5-dimethyl-1,3-thiazolidine-4-carboxamide;
- 5 *tert*-Butyl 4-({[4-(2-butynyloxy)phenyl]sulfonyl}amino)-4-[(hydroxyamino)carbonyl]-1-piperidinecarboxylate;
- 4-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-4-piperidinecarboxamide;
- 10 1-Benzoyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
- 1-Benzyl-4-{[4-(2-butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
- 15 *tert*-Butyl 4-{[4-(2-butynyloxy)phenyl]sulfonyl}-5-[(hydroxyamino)carbonyl]-1,4-diazepane-1-carboxylate;
- 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-diazepane-5-carboxamide;
- 20 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1-methyl-1,4-diazepane-5-carboxamide;
- 4-{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-1,4-thiazepine-5-carboxamide;
- 25 (2R)-5-(Acetylamino)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
- N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]thiophene-2-carboxamide;
- 30 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{[(ethylamino)carbonyl]amino}-N-hydroxypentanamide;
- 35 (2R)-5-[(Anilinocarbonyl)amino]-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypentanamide;
- Octyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
- 40 4-Methoxyphenyl (4R)-4-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentylcarbamate;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{[(diethylamino)carbonyl]amino}-N-hydroxypentanamide;
- 45

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- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
{[(methylanilino)carbonyl]amino}pentanamide;
- 5 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
{[(1-methyl-1H-imidazol-4-yl)sulfonyl]amino}pentanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
{[(2-morpholin-4-ylacetyl)amino]pentanamide};
- 10 (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
{[(2-(4-methylpiperazin-1-yl)acetyl)amino]pentanamide};
- (2R)-5-{{[2-(Benzylamino)acetyl]amino}-2-({[4-(but-2-ynyloxy)phenyl]-
sulfonyl}amino)-N-hydroxypentanamide};
- 15 (3S)-4-{{[4-(2-Butynyloxy)phenyl]sulfonyl}-N-hydroxy-2,2-dimethyl-3,4-
dihydro-2H-1,4-thiazine-3-carboxamide};
- (2R)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
[(imino{[(4-methoxy-2,3,6-trimethylphenyl)sulfonyl]amino}methyl)amino]-
pentanamide;
- (2R)-2-(4-But-2-ynyloxy-benzenesulfonylamino)-5-guanidino-pentanoic acid
hydroxyamide;
- (2R)-2-({[4-(2-Butynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-
[(imino{[(4-methylphenyl)sulfonyl]amino}methyl)amino]pentanamide;
- (3R)-3-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-4-(hydroxyamino)-4-
oxobutanoic acid;
- (2S)-3-(*tert*-Butylthio)-2-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-N-
hydroxypropanamide;
- (2S)-3-{{[Acetylamino]methyl}thio}-2-({[4-(but-2-
ynyloxy)phenyl]sulfonyl}amino)-N-hydroxypropanamide;
- (2S)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-3-
[(4-methylbenzyl)thio]propanamide;
- (2S)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-3-
[(4-methoxybenzyl)thio]propanamide;
- (2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-
hydroxypentanediamide;

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- (4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentanoic acid;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-4-phenylbutanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-(1H-imidazol-5-yl)propanamide;
- (2R,4S)-1-([4-(But-2-ynyloxy)phenyl]sulfonyl)-N,4-dihydroxypyrrolidine-2-carboxamide;
- (2R)-6-Amino-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxyhexanamide;
- Benzyl (5R)-5-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-6-(hydroxyamino)-6-oxohexylcarbamate;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-(1-naphthyl)propanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-(2-naphthyl)propanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxyhexanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide;
- (2R)-5-Amino-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-3-(3,4-difluorophenyl)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-3-(4-fluorophenyl)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-(4-nitrophenyl)propanamide;
- (2R)-1-([4-(But-2-ynyloxy)phenyl]sulfonyl)-N-hydroxypiperidine-2-carboxamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N,3-dihydroxypropanamide;

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- (2R)-3-(Benzyloxy)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-3-thien-2-ylpropanamide;
- (2R,3S)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N,3-dihydroxybutanamide;
- (2R,3S)-3-(Benzyloxy)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxybutanamide;
- (4S)-3-{[4-(But-2-ynyloxy)phenyl]sulfonyl}-N-hydroxy-1,3-thiazolidine-4-carboxamide;
- (3R)-2-{[4-(But-2-ynyloxy)phenyl]sulfonyl}-N-hydroxy-1,2,3,4-tetrahydroisoquinoline-3-carboxamide;
- (2R)-3-[4-(Benzyloxy)phenyl]-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypropanamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-2-phenylethanamide;
- (2R)-5-(Acetylamino)-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentyl]-1H-benzimidazole-5-carboxamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentyl]benzamide;
- 4-Bromo-N-[(4R)-4-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentyl]benzamide;
- (2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(butyrylamino)-N-hydroxypentanamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentyl]-3-chlorothiophene-2-carboxamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentyl]-4-chlorobenzamide;
- N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-

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oxopentyl]cyclohexanecarboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-{[2-(3,4-dichlorophenyl)acetyl]amino}-N-hydroxypentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-2,5-dimethyl-3-furamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-3,5-dimethylisoxazole-4-carboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-[(3-phenylpropanoyl)amino]pentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]isonicotinamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]nicotinamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-2-methoxybenzamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-4-methoxybenzamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-{[2-(4-nitrophenyl)acetyl]amino}pentanamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-5-[(2-phenylacetyl)amino]pentanamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]quinoline-3-carboxamide;

N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]thiophene-3-carboxamide;

(E)-N-[(4R)-4-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-5-(hydroxyamino)-5-oxopentyl]-3-phenylprop-2-enamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-1H-benzimidazole-5-carboxamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]benzamide;

4-Bromo-N-[(5R)-5-({[4-(but-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]benzamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-3-chlorothiophene-2-carboxamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-4-chlorobenzamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]cyclohexanecarboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-{[2-(3,4-dichlorophenyl)acetyl]amino}-N-hydroxyhexanamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-2,5-dimethyl-3-furamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-3,5-dimethylisoxazole-4-carboxamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-6-[(3-phenylpropanoyl)amino]hexanamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]isonicotinamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-2-methoxybenzamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]-4-methoxybenzamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-6-{[2-(4-nitrophenyl)acetyl]amino}hexanamide;

(2R)-2-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-N-hydroxy-6-[(2-phenylacetyl)amino]hexanamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]quinoline-3-carboxamide;

N-[(5R)-5-({[4-(But-2-ynyloxy)phenyl]sulfonyl}amino)-6-(hydroxyamino)-6-oxohexyl]thiophene-3-carboxamide;

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(E)-N-[(5R)-5-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-6-(hydroxyamino)-6-oxohexyl]-3-phenylprop-2-enamide;

(Z)-N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]octadec-9-enamide;

N-[(4R)-4-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino]-5-(hydroxyamino)-5-oxopentyl]thiophene-2-carboxamide;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-
{[(ethylamino)carbonyl]amino}-N-hydroxypentanamide;

(2R)-5-[(Anilinocarbonyl)amino]-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide;

Octyl (4R)-4-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentylcarbamate;

4-Methoxyphenyl (4R)-4-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-5-(hydroxyamino)-5-oxopentylcarbamate;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-5-[[diethylamino)-carbonyl]amino}-N-hydroxypentanamide;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-
{[(methylanilino)carbonyl]amino}pentanamide;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-[(1-methyl-1H-imidazol-4-yl)sulfonyl]amino}pentanamide;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-[(2-morpholin-4-ylacetyl)amino]pentanamide;

(2R)-2-([4-(But-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxy-5-[[2-(4-methylpiperazin-1-yl)acetyl]amino}pentanamide; and

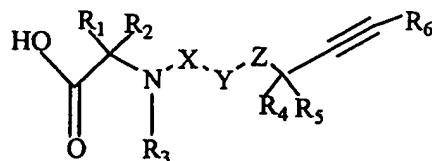
(2R)-5-[[2-(Benzylamino)acetyl]amino]-2-([4-(but-2-ynyloxy)phenyl]sulfonyl)amino)-N-hydroxypentanamide;

or a pharmaceutical salt thereof.

14. A process for preparing a compound of formula B, as defined in claim 1, which comprises one of the following:

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- a) reacting a compound of formula V:

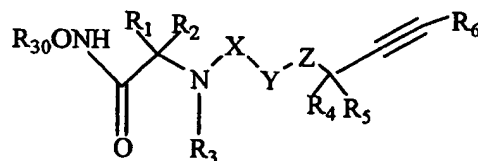


(V)

- wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , X , Y and Z are defined in claim 1, or a reactive derivative thereof, with hydroxylamine to give a corresponding compound of formula B;

or

- b) deprotecting a compound of formula VI:

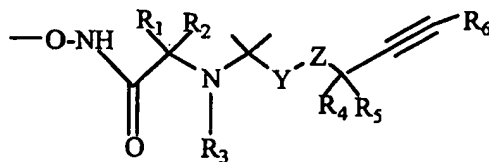


(VI)

- wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , X , Y and Z are defined in claim 1, and R_{30} is a suitable protecting group such as t-butyl, benzyl, and trialkylsilyl, to give a corresponding compound of formula B

or

- c) cleaving a resin supported hydroxamate derivative containing the group:



15

to give a compound of formula B as defined in claim 1;

or

- d) resolving a mixture (e.g. racemate) of optically active isomers of a compound of formula B to isolate one enantiomer or diastereomer substantially free of the other enantiomer or diastereomers;

20

or

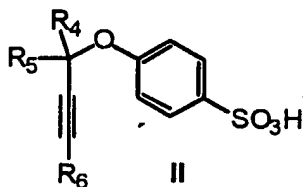
- e) acidifying a basic compound of formula B with a pharmaceutically acceptable acid to give a pharmaceutically acceptable salt;

or

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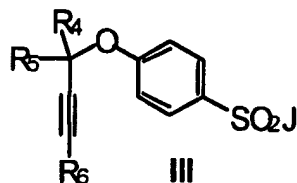
f) converting a compound of formula **B** having a reactive substituent group or site to give a compound of formula **B** having a different substituent group or site.

15. A compound of formula **II**,



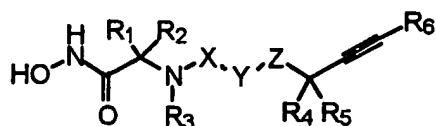
with the proviso that R_6 is not hydrogen and R_4 , R_5 and R_6 are as defined in Claim 1.

16. A compound of formula **III**,



with the proviso that R_6 is not hydrogen wherein J is fluorine, bromine, chlorine, 1,2,4-triazolyl, benzotriazolyl or imidazol-yl, and R_4 , R_5 and R_6 are as defined in Claim 1.

17. A method of inhibiting pathological changes mediated by TNF- α converting enzyme (TACE) in a mammal in need thereof which comprises administering to said mammal a therapeutically effective amount of a compound having the formula



wherein:

X is SO_2 or $-\text{P}(\text{O})-\text{R}_{10}$;

Y is aryl or heteroaryl, with the proviso that X and Z may not be bonded to adjacent atoms of Y;

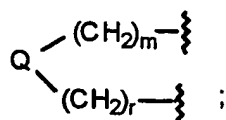
Z is O, NH, CH_2 or S;

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R_1 is hydrogen, aryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

R_2 is hydrogen, aryl, aralkyl, heteroaryl, heteroaralkyl, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

or R_1 and R_2 , together with the atom to which they are attached, may form a ring wherein R_1 and R_2 represent a divalent moiety of the formula:



wherein

Q = a carbon-carbon single or double bond, O, S, SO, SO₂, -N- R_{11} , or -CON- R_{14} ;

$m = 1-3$;

$r = 1$ or 2 , with the proviso that when Q is a bond, r is equal to 2 ;

R_3 is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, aralkyl, or heteroaralkyl;

or R_1 and R_3 , together with the atoms to which they are attached, may form a 5 to 8 membered ring wherein R_1 and R_3 represent divalent moieties of the formulae:



wherein Q and m are as defined above;

A is aryl or heteroaryl;

s is 0-3;

u is 1-4;

R_4 and R_5 are each, independently, hydrogen or alkyl of 1-6 carbon atoms, -CN, or -CCH;

R_6 is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, or -C5-C8-cycloheteroalkyl;

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R_8 and R_9 are each, independently, hydrogen, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, aralkyl, heteroaryl, heteroaralkyl, or -C4-C8-cycloheteroalkyl;

5 R_{10} is alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl or heteroaryl;

R_{11} is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -S(O) $_n$ R_8 , -COOR $_8$, -CONR $_8$ R $_9$, -SO $_2$ NR $_8$ R $_9$, or -COR $_8$;

10 R_{12} and R_{13} are independently selected from H, -OR $_8$, -NR $_8$ R $_9$, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -COOR $_8$; -CONR $_8$ R $_9$; or R_{12} and R_{13} together form a -C3-C6-cycloalkyl of 3-6 carbon atoms or a -C5-C8-cycloheteroalkyl ring; or R_{12} and R_{13} together with the carbon to which they are attached, form a carbonyl group;

15 with the proviso that R_{10} and R_{12} or R_{11} and R_{12} may form a cycloheteroalkyl ring when they are attached to adjacent atoms;

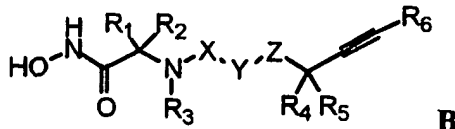
R_{14} is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms or cycloalkyl of 3-6 carbon atoms;

20 and n is 0-2;

or a pharmaceutically acceptable salt thereof.

18. The method according to Claim 17 wherein the condition treated is rheumatoid arthritis, graft rejection, cachexia, inflammation, fever, insulin resistance, 25 septic shock, congestive heart failure, inflammatory disease of the central nervous system, inflammatory bowel disease or HIV infection.

19. A pharmaceutical composition comprising a compound having the formula



30

wherein:

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X is SO_2 or $-\text{P}(\text{O})-\text{R}_{10}$;

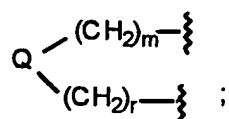
Y is aryl or heteroaryl, with the proviso that X and Z may not be bonded to adjacent atoms of Y;

Z is O, NH, CH_2 or S;

5 R_1 is hydrogen, aryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

R_2 is hydrogen, aryl, aralkyl, heteroaryl, heteroaralkyl, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms;

10 or R_1 and R_2 , together with the atom to which they are attached, may form a ring wherein R_1 and R_2 represent a divalent moiety of the formula:



wherein

Q = a carbon-carbon single or double bond, O, S, SO , SO_2 , $-\text{N}-\text{R}_{11}$, or
15 $-\text{CONR}_{14}$;

$m = 1-3$;

$r = 1$ or 2 , with the proviso that when Q is a bond, r is equal to 2 ;

R_3 is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, C4-C8 cycloheteroalkyl, aralkyl, or heteroaralkyl;

20 or R_1 and R_3 , together with the atoms to which they are attached, may form a 5 to 8 membered ring wherein R_1 and R_3 represent divalent moieties of the formulae:



wherein Q and m are as defined above;

25 A is aryl or heteroaryl;

s is 0-3;

u is 1-4;

R_4 and R_5 are each, independently, hydrogen or alkyl of 1-6 carbon atoms,

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-CN, or -CCH;

R_6 is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, or -C5-C8-cycloheteroalkyl;

5 R_8 and R_9 are each, independently, hydrogen, alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, aralkyl, heteroaryl, heteroaralkyl, or -C4-C8-cycloheteroalkyl;

10 R_{10} is alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl or heteroaryl;

R_{11} is hydrogen, alkyl of 1-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -S(O) $_n$ R_8 , -COOR $_8$, -CONR $_8$ R_9 , -SO $_2$ NR $_8$ R_9 or -COR $_8$;

15 R_{12} and R_{13} are independently selected from H, -OR $_8$, -NR $_8$ R_9 , alkyl of 1-6 carbon atoms, alkenyl of 2-6 carbon atoms, alkynyl of 2-6 carbon atoms, cycloalkyl of 3-6 carbon atoms, aryl, heteroaryl, -COOR $_8$; -CONR $_8$ R_9 ; or R_{12} and R_{13} together form a -C3-C6-cycloalkyl of 3-6 carbon atoms or a -C5-C8-cycloheteroalkyl ring; or R_{12} and R_{13} , together with the carbon to which they are attached, form a carbonyl group;

20 with the proviso that R_{10} and R_{12} or R_{11} and R_{12} may form a cycloheteroalkyl ring when they are attached to adjacent atoms;

R_{14} is hydrogen, aryl, heteroaryl, alkyl of 1-6 carbon atoms or cycloalkyl of 3-6 carbon atoms;

and n is 0-2;

25 or a pharmaceutically acceptable salt thereof.